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Why do students choose computing? influences, perceptions and engagement

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Why do students choose computing?: influences, perceptions and engagement

Ann Louise 'Lisa' Payne

A thesis submitted in partial fulfilment of the University's requirements for the Degree of
Doctor of Philosophy

Coventry University

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Why? Computing



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Dedication

*This thesis is dedicated to all those dedicated colleagues, past or still in post,
who worked their socks off trying to make a difference.*

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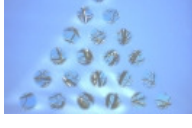

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Style and Notation

Participant attribution codes

Codes such as **Omar-2 # 217** should be interpreted as:

Omar: participant pseudonym

-2: engagement number (mostly meetings or interviews)

#217: talk-turn number, within that meeting or interview.

Use of ellipses (...)

The use of an ellipsis '...' is potentially ambiguous when used within dialogue. In dialogue, this has been used to represent a pause or fade-away. The omission of a portion of the dialogue is shown by the use of a bracketed ellipsis '[...]'. This latter is a convention suggested by Potter and Wetherell (1994). In quotations from literature, the simpler unbracketed form is used to indicate omission.

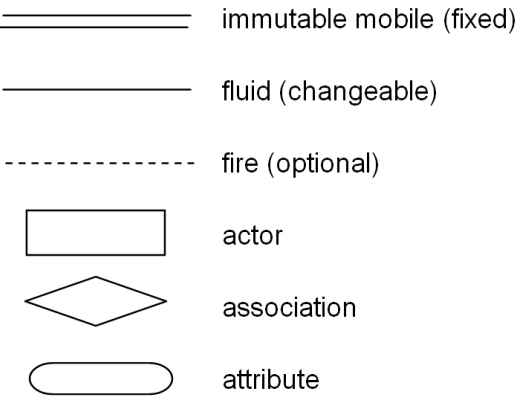
Terminology

The term 'pupil' is used to refer to learners of school age. The term 'student' refers to older learners, here usually studying at university.

The term 'computing' (lower-case) is used to refer to the whole cognate area or a group of related courses, with 'Computing' (upper-case) referring to a course title. 'IT' (or IT&T) is generally used to refer to the industry.

These usages are introduced in the text.

ANT diagram notation



Abstract

The '*Why Computing?*' project is a constructivist-interpretive study which arose from concerns over many years of practice as an academic, as to why some students enrolled on computing degrees when they had no apparent interest in the subject. To check that these were wider concerns, not just personal or local, work started by interviewing academics from diverse universities. This confirmed the broad prevalence of low levels of apparent disengagement. Empirical data were collected, from current and potential students, over a period of up to 18-months, as they chose their course and progressed into Higher Education. This included 100 hours of focus group and individual interviews.

Three theoretical lenses were selected for use as analytical tools: Actor-Network Theory was supported by Structure-Agency and Social Practice theories. From the initial objective, three themes emerged as work progressed: the image of computing, student choice and engagement, each of which led to evolving and focussing, research questions.

Empirical data confirmed the current, largely anecdotal, understandings that the image of computing, particularly its 'geeky-ness', deters some applicants and that many pupils have an incorrect understanding of the likely content of an HE computing course, often conflating it with school ICT.

New insights include that those pupils who do have a reasonable understanding of what technical computing courses encompass have usually gained it through their social networks (often parents): seldom through school. Some students who might be seen as disengaged can be fully committed to their course, but behaving in ways different to that planned by course designers, and may be better considered 'differently engaged'. Models of the characteristics of engagement are developed. Finally, some computing degree students value the opportunity to exercise their creativity.

ANT Analysis Diagrams were developed as an analytical tool which can be re-used in many contexts. Implications for stakeholders are presented.

1 : The '*Why Computing?*' project



Figure 1-1: Wordle of text in this thesis¹

¹ Created at <http://www.wordle.net>

*"It's a dangerous business, Frodo, going out your door. You step onto the road, and if you don't keep your feet, there's no knowing where you might be swept off to."*²

1.1 Introduction

When embarking on writing an extended narrative it is always awkward to know where best to start. So, invoking the cliché of childhood storytelling, I will commence by saying: *"Once upon a time there was a Computer Science academic who wanted to understand why things were as they were"*. I will shortly elaborate more fully on my background and my motivations for embarking on this work but that provides the general context. In this thesis I will provide an account of the constructivist-interpretivist research project which I set up in order to seek meaning in, and generate an improved understanding of, the issues concerning why some students choose to study computing, and why others decide not to. I branded this research the 'Why Computing?' project.

There have been few academic studies of this area and most of those are quantitative, postivist work seeking patterns in data which suggest causation, rather than a quest for revelations, through understanding meaning for individuals. In this work I have endeavoured to help to fill that gap and to create a richer, more developed understanding of the issues at play. My research has led me to explore a range of areas and underlying issues. I created the WordleTM, shown in Figure 1-1, as an analysis of the words used in this thesis, which highlights graphically the topics discussed.

In this project the empirical data gathered provided confirmatory evidence of a number of issues which were anecdotally recognised in the computing academic community but seem not to be supported by specific data and have been explored very little in the literature. This includes the poor level of understanding amongst many pupils about the nature and content of computing – often being

² J. R. R. Tolkien (1954) *The Fellowship of the Ring*. (The Lord of the Rings trilogy), London: Allen and Unwin

confused with Information and Communication Technologies (ICT) – and the impact of the 'geek', a stereotype often associated with computing (Chapter 5).

I also came to a number of fresh understandings which form my main claims to contributions to the domain. Firstly, currently most pupils have few opportunities to get any exposure to technical computing that would afford them the opportunity to see its nature and those who do, mostly gain it through a parent or friend (or rarely a teacher) (Chapter 6). Secondly, enjoyment of a computing course, for some students, is affected by the flexibility and choice available to them (Chapters 6 and 7). Three tentative models of student engagement are presented. Lastly, students who do not conform to expected patterns of academic work, can be labelled as being disengaged when it may be more appropriate to consider them to be 'differently engaged' (Chapter 7).

As well as these contributions I also have two methodological contributions to offer. I developed a diagramming notation which can assist with operationalising elements of Actor-Network Theory (ANT) as an analysis tool (Chapter 4). In addition, when considering networks of actors it is as useful to investigate the nature of those actors' relationships as well as the actors themselves (§8.6.1). All these findings will be explored and developed later.

In this chapter I will set out the context of my work. I will first say a little more about my motivation in conducting this research and introduce the questions which underpin my work. This is followed by a section in which I introduce myself properly, so that the reader can appreciate my background. Perhaps this will assist the reader in understanding why I have privileged some matters and avenues over others or why I interpret things as I do. This is not offered as some form of excuse but rather so the reader can contextualise my interpretation. In particular I discuss the matter of insider research: the difficulties and advantages of being within the domain of a research investigation. I will follow this with some comments about the writing style adopted. Since one issue which was significant to the research was terminological confusion and inconsistency, I will explore this and describe how I will use the relevant terms. Following a

description of the scope of this project I conclude the chapter by mapping out the contents of the remainder of this thesis.

1.2 Why am I here?

I was motivated to undertake this study by my experiences as an academic, teaching computing students over a period of very many years. The taking on of various administrative roles led me to an ever increasing awareness of, and concern about, the poor performance and engagement of some students. Initiatives and support were put in place – although as always in such situations no doubt more could have been done – but the underlying cause (or causes) seemed largely resistant to intervention. Significant numbers of students continued to absent themselves from classes or failed to perform adequately or were simply unhappy with their course. Some students gave the impression of not wanting to be there and being resistant to academics' attempts to support or guide them. In conversation with some I might be left wondering: "*As you have no apparent interest in your course, why are you here? What were the processes which led to you being here? Why are you not doing something more interesting to you?*" As part of my professional work I would discuss these concerns both with colleagues at Coventry but also at events attended by a broader range of academics. Some tentative explanations might be suggested but there seemed to be little in the computing academic community by way of a deep understanding of the dynamics at work. Thus, this study arose from the pain of my personal practice and a personal desire to see appropriate students enrol.

Despite this background it seemed judicious to start research by checking that this was a *bona fide* area for study: that these were more than personal concerns. A preliminary study was conducted, interviewing academics at a wide range of universities, to gather their views. Concerns about student engagement were widespread in the computing academic community, partially as a response to poor student retention. The scholarly literature revealed very little understanding about the views and behaviours of these particular students: this research was worth pursuing.

I designed this research to develop the fuller, richer understanding of the processes and influences affecting computing students' choosing and engagement, which was very limited in the existing academic literature. Through this knowledge I hope that it is possible for the academic community, and other stakeholders, to make the necessary changes so that fewer students end up on computing courses only to be unhappy and disenchanted. In parallel, maybe some other groups of youngsters can come to be aware that computing could suit them well. By getting students who are more suited to these courses we will get more successful, happier students. The study focussed on the processes leading to choosing a course and enrolment, rather than students' teaching and learning experiences on course. Inevitably some issues related to this were raised but a systematic exploration of the teaching and learning of Computing in Higher Education (HE) would have been a different project.

A number of external events occurred in parallel with this research, in particular a number of influential reports and a revised National Curriculum for state schools were published. There was an explosion of interest in, and publicity of, many of the concerns and issues I raise, such as pupils' current lack of exposure to computing. Sometimes it felt that my work was a little late but in general the timing was fortuitous. These are issues which are starting to be addressed.

The initial project objective was to investigate why some students enrol on an HE computing course when they do not seem interested in computing, their motivations in doing so, and the processes which led to them enrolling. As work progressed, and particularly during analysis, interest focussed around three main themes which emerged – image, choice and engagement. In turn these themes generated research questions, which evolved, and served to further tighten the research focus. Thus my resulting research question, and its sub-questions, were:

What influences students' choice, perception of, and engagement with, computing courses and what are the implications for Higher Education in England?

- *How do young people perceive the image and nature of computing as a subject and profession? This includes how they relate to computing personally and the stereotypes of 'nerd' and 'geek'.*
- *What factors lead school pupils to choose to study a computing course at university? This includes the extent to which it is an active choice and the sources of advice and information which they use.*
- *What leads to some computing students to seem to disengage from their course? This includes the factors which affect engagement and how disengagement is represented.*

These three sub-questions, with their associated themes, are each the subject of an analysis chapter.

This series of questions led me to consider young people as they progress through the various educational stages, from considering what to apply to study at university through to when they enrol and settle down into their course. Whilst I did pay some attention to students at later stages of their university programmes, it was any early transitional issues which were of most interest, being a reflection of how their course fitted students' expectations.

The students of main interest were those on main-stream, technical courses, such as Computer Science. However there were issues which made it impossible and inappropriate to limit research to this single degree title. These scoping and eligibility issues are introduced in §1.6 and further elaborated in Chapter 4. Whilst gender is not specifically addressed in this research, the scarcity of females is so significant for the computing discipline that I will draw in gender issues when appropriate. Having set out the outline of my research I shall move next to introducing myself more fully and discussing some of the issues related to the context in which I was conducting my research.

1.3 *"I want to try to put my cards on the table – in so far as I know what my own cards are."*⁸

My study aimed to understand why and how students make choices and decisions. It was about gaining as deep an understanding as possible of the

³ Adorno 2008:5

processes, tensions and rationales at play. I wanted to gain some insights into the 'lived reality' of participating students. However, particularly in interpretive research, the relationship between the researcher and the participants affects the research outcomes.

"There has long been a tendency to view the self of the social science observer as a potential contaminant, something to be separated out, neutralized, minimized, standardized and controlled" (Fine et al. 2000:108).

Hence in this section I will reflectively and reflexively consider the issues associated with my position within this study. In particular I will consider issues related to my roles and relationships.

An insider researcher is someone who is investigating a community of which they are part. The community may be any group with something that members share in common. This might be a language, identity or experience (Asselin 2003) or any other form of commonality, such as roles or responsibilities.

"Insiderness' is not a fixed value" (Trowler 2012a:91) but depends upon which aspect of the context is being researched. As will be seen, I can be considered to be an insider to the context of this study, although one with elements of outsider-ness.

1.3.1 Who am I?

For a period of over 25 years I was employed as a lecturer of Computer Science (CS), mostly at Coventry University. However my background is not entirely in the area of computing. My first degree was in Environmental Sciences. It was really a course in Geography, considered from a scientific standpoint. I learned about ecology, about glacial motion and hydrology and population dynamics. We all studied statistics. We were taught to think and work within the scientific method, using rigorous measurement, testing and analysis. It suited me well: I loved it.

I read for this degree at the University of East Anglia. I was there in its very early years, soon after it started to enrol students. It was an exciting place to be; one which thrived on innovation. Its motto is *'Do Different'*. University management

recognised that computers would be important in the future and they wanted all students to have some experience. In line with opportunities and thinking at that time every student, across all disciplines, both undergraduate and postgraduate, was required to take a short course in FORTRAN programming. This was my first exposure to computing. I took to it well: it was so logical. I well remember the sense of achievement as a new first-year student at being able to help struggling postgraduates.

Almost my entire working career has been in the field of computing, initially in technical roles in industry. Those were quite early days in the development of computing. In later chapters I will be discussing the significance of the geeky image often associated with the contemporary computing profession. But back then I believe computing was perceived entirely positively, as a desirable, reasonably well-paid career. The products of most of the work done were largely invisible to the general public, creating systems which provided back-office business support. It probably had an element of mystery, even. There was nothing remotely akin the stereotype of the geek. I would not have wished to be associated with a profession which was seen as being composed of obsessives with poor social skills, but when I joined the image was more one of comprising the bright, logical and well-paid.

Moving into computing academia was an entry into a new world and brought its own challenges and difficulties. Over time this led me to my concerns about some students' motivation and their progression (§1.2).

In the spring of 2010, Coventry University offered academics the chance to bid for funded PhD studentships in the area of Education. I assembled a supportive, highly-respected supervision team; the Faculty agreed to provide the necessary match-funding and I submitted a bid for funding for this project. Perhaps helped by the history of institutional concern about the computing subject area, my bid was one of the two which secured funding that year. I had created a way to undertake this study as a funded, full-time, research student. Agreement was secured to remain as an Honorary Lecturer within my department, retaining some staff privileges. This meant I also retained close contact with my academic

colleagues, which was important for providing routes to access potential participants. Alongside this research work for the first two years I retained some of my previous teaching responsibilities.

Over the duration of my research my position changed and I became less closely linked into the department. My teaching role diminished so that by the end I had no direct, formal contact with any students; students who I had taught and knew me had mostly completed their studies and moved on; several people who were both long-standing colleagues and close friends had departed and I barely recognised many of the new staff. There was also a change of Head of Department. Whilst the new Head was supportive of the project she brought her own views on priorities and ways of working. Thus, this research was largely undertaken during a period when I was full-time student; part-time lecturer and Honorary Lecturer.

As I will describe in Chapter 4, my research participants were of three types. I was working with fellow Computer Science academics, from Coventry and elsewhere; with current computing students and with prospective students. To CS academics or members of the Department of Computing at Coventry I would be seen as an 'insider'. I did not have direct teaching responsibility for most of the participants, even those who were students enrolled at Coventry. Nonetheless they understandably saw me as a member of faculty. The tensions and issues differ in each of these situations, but also it is not a simple dichotomy between being an insider or an outsider.

1.3.2 Want to be an outsider...

Despite the recognition that knowledge and understandings are socially constructed, within many research paradigms there is a desire to strive for objectivity (Arber 2006). In this project I aimed for objectivity although, since it is interpretive in character, in many respects it is inherently subjective. To this end, being an outsider to most student participants was an advantage. Most students did not know me as teacher and therefore tended to see me just as a researcher in the Faculty, someone interested in who they are and what they had to say. Nonetheless some would tend to see me as part of 'the establishment' and

therefore an insider. Whilst the issues being discussed in this research were not particularly sensitive ones, as an outsider it was easier, and more convincing, to reassure participants that confidentiality would be fully respected.

Being an outsider does confer other benefits. As Dwyer and Buckle (2009) describe, an outsider, viewing a situation from a distance may be able to see through the complexities and discern a wider view of a situation. In my case I cannot claim that I was an outsider in terms of my own relationship with this study. However I did recognise the associated risks and aimed to keep an open mind throughout the project.

Nevertheless, there are always tensions even if the researcher is an outsider. The researcher is looking for 'findings': they may already have hunches, ideas or prejudices which they are pursuing. Even if they do not bear a personal agenda, either consciously or unconsciously, the researcher does bring 'themselves' into the research despite, often, presenting: "*a cloak of alleged neutrality*" (Fine *et al.* 2000:109).

There were some groups of participants for whom I would tend to be considered to be an insider. These are the participants who were staff and some of the Coventry University student participants. Being an insider also involves some benefits and some difficulties.

1.3.3 But also an insider...

Any constructivist approach to research requires respondents to share their stories in the spirit of openness. Being an insider can be helpful in achieving this since an insider is automatically given a measure of privilege. They are known to other members of the community and are already inside it. This allows a more rapid and fuller acceptance of the research activity by the community (Dwyer and Buckle 2009, Trowler 2012a). Asselin (2003) observes that the degree of trust and access granted will depend on the level of rapport present in the relationship in the past. I am well known to, and I believe respected by, colleagues. In this work most people have afforded me a good level of support in my work.

Generally it was quite easy to gain agreement for the range of research interactions.

As an insider I had a number of other significant advantages and benefits. I know how the department works. I understand who is who and who does what; the context, course structures and much of the micro-politics (Bell 1999). This made it relatively easy to recruit and work with participants and it was even possible to deliver a research study which linked tightly into a student assessment. This would simply not have been possible for someone less embedded in the department.

However the advantages of being an insider were not restricted to the organisational. As an insider participants understandably presume that I am interested in the subject of computing, providing a *prima facie* bond. However this research was, in part, endeavouring to contact students and applicants who had a misunderstanding about the nature and content of courses. For these participants any bonding would be weakened and may even collapse if and when they become aware of the real nature of the subject of computing and their misunderstandings about it. Certainly when a potential applicant told me that they were applying for a computing degree because they were really enjoying their ICT A-level, they became quiet and reticent when I pointed out that there was little similarity in content. It was important to point out their misperception: to do anything else would have been to be complicit in their misunderstanding, even though it meant stepping out of the researcher role.

It was possible to have conversations about course-related issues which participants might have found to be beneficial, since I could appreciate some of their difficulties (Bell 1999). In conversation with internal participants it was very often helpful to be able to 'identify with' and support a point they made or sometimes to provide them with some information or background. This enhanced the conversations and allowed them to feel more involved. We got closer as a result. However this led to me slipping out of my researcher role, generating a source of potential role confusion.

"Role confusion exists when the researcher perceives or responds to events or analyzes data from a perspective other than researcher" (Asselin 2003:102).

Care was needed to ensure that these 'aside conversations' remained professional and 'unproblematic' but it was possible to return to researcher-mode by simply saying something like, *"Shall we get back to the research topic?"*, making the point that I had deviated from my overt role.

Avoiding bias is a particularly difficult issue as an insider (Bell 1999, Asselin 2003). As an insider, prior knowledge and perceptions help to guide and inform the research design and interpretation. Mutual knowledge shared with participants gives the researcher *"greater access to actors' implicit meanings"* (Trowler 2012a:111). As an insider the *"researcher is empowered to offer a thick description of lived realities"* (Trowler 2012a:118) of participants. It is by getting into the detail, *"hovering so low over the interpretations"* (Geertz 1973:25), that these thick descriptions can generate theoretical understandings.

However the corollary of this is that this commonality can also lead to slanted, distorted interpretations and even the overlooking of potential, emerging concepts (Dwyer and Buckle 2009). Such insider bias can put at risk the validity and trustworthiness of the research. The researcher needs to:

"assume he or she knows nothing about the phenomenon under study and start gathering data from a fresh perspective with his or her 'eyes open' " (Asselin 2003:100).

This can be seen as trying to view the domain as an *"interested-but-ignorant bystander"* (Angrosino and de Perez 2000:684). Nonetheless as an insider *"it becomes particularly difficult to render the normal strange"* (Trowler 2012a:405). It is not possible to unknow what you (think you) already know. However it is possible to treat such prior knowledge with a degree of scepticism and to try to look through another's eyes. However assumptions can *"limit the researcher's ability to probe for deeper meaning or understanding"* (Asselin 2003:100). It is possible to try to ensure that you do not jump to premature conclusions, although this is hard to achieve. It is possible to try to dig deep to reveal any covert

meanings and not just move on when a familiar response is received (Dwyer and Buckle 2009).

Rather than attempt to conduct the research as an outsider it is more appropriate to try to articulate and be explicit about the tacit knowledge, theories and assumptions employed by those within the domain. In this way they are available for scrutiny both within the research and by others (Trowler 2012b). Being explicit in this way increases the credibility of the research. I shall therefore identify such material when appropriate.

1.3.4 The balancing act

In many situations the researcher is working as both outsider and insider. Trowler (2012a) believes that there is a continuum between insider and outsider positions. A researcher is always partially both, and can never be solely either.

"We may be closer to the insider position or closer to the outsider position, but because our perspective is shaped by our position as a researcher... we cannot fully occupy one or other of those positions" (Dwyer and Buckle 2009:61).

Collins (1986) coined the term 'outsider-within'. She observed that those Black women who become academic sociologists, and understand and can work within the sociology paradigms, and who still retain their Black worldview, are in a better position to study Black issues as they have a "*creative potential of their outsider-within status*" (Collins 1986:S30).

My situation in this research is slightly different. Here, I, as a fully-embedded insider had moved to a new role as researcher, trying to adopt the viewpoint of an outsider: rather more of a position of an 'insider-without'. There are advantages of straddling the divide and a reflexive awareness of my roles and status led to a number of situations where actions were designed or adjusted in an attempt to reduce the power differential between researcher and participant (Finlay 2002).

As described by Arber (2006), to adopt good practice, the various roles need to be balanced throughout the research process. At times it was possible to operate as an outside researcher, albeit one with the views and subjectivities of

an insider. At other times work was completed in the role of an insider, though one who had the remit of conducting investigations. Bott (2010) describes this as endeavouring to establish and maintain an equal relationship with participants which is both nurturing and one of mutual exchange. By revealing (some of) the self, leading to something closer to a balance of vulnerabilities, helps establish trust and participant engagement. However this is difficult to achieve in contexts such as this where the researcher has both an insider and an outsider identity.

Bell (1999) believes that the conflict between teacher and researcher, insider and outsider, can be difficult to reconcile. In the context of running this research project, teacher and researcher were my explicit roles. Balancing these roles certainly did require careful consideration of a multitude of issues. The circumstances of the current study meant that most situations were handled by paying heed to the requirement to preserve anonymity and confidentiality and the desire not to cause problems.

There were ongoing background tensions though. Whilst I had a role as teacher during the research period, I did not personally teach most of the students targeted in this study, although I did teach some of them. Reassuring them of a separation of concerns was important but was also impossible to fully achieve. For other participants it would have been disingenuous not to tell them of my lecturing role. Thus, all participants who were also students enrolled on a Coventry University course were informed that I had some teaching duties. Of course this status means that an equal relationship with participants can never be achieved, no matter how it is established and nurtured. The imbalance is not just one of insider/outsider but also one which is tinged, at the very least, with authority and power.

Participants who were students inevitably initially viewed me as a lecturer. They will attribute some degree of authority and power: they will assume I have some influence and can affect their position on their course. Similarly potential course applicants will tend to assume that I can influence the outcome of their course application. In both cases in order to free participants to contribute fully, in as uninhibited a manner as possible, I needed to reassure them. However there is

always likely to be a residue of doubt which might encourage participation but might also inhibit full disclosure.

Paying attention to these challenges and tensions within and between roles can lead to improving the quality of the research (Bott 2010). I needed to balance involvement with detachment, the balance changing at different times (Arber 2006). When discussing course related issues and tensions I should not feign unawareness and certainly should not take a more formal 'authoritarian' course management stance. I needed to encourage discussion, delve for a deeper understanding from a student perspective, whilst not being judgemental.

The role of 'outsider-within' has been an interesting and useful one. It certainly has conferred advantage over that of the outsider. It made many things easier and permitted some things which would otherwise have been impossible. It has also conferred some advantage over that of an insider too. A measure of externality has helped with some forms of interaction. But an insider role is not, here, the same as being an equal or peer of the participants. With academic participants I was both an insider and an equal, but with student and applicant participants I, inevitably, remained as 'other'.

1.4 Some matters of style

I have written this chapter from a first-person point of view, in recognition of my personal involvement in the issues discussed. For the majority of the thesis I will use my more normal, third-person style, adopting the traditional, academic convention, returning to first-person when I present my conclusions and discuss the implications.

Most chapters are interpretive and discursive in nature presenting the underpinning theories, my empirical materials and my findings. However some have a terser, less fluid style, particularly where I present some factual material and statistics as background. This does produce a disjunction in tone but at each stage a style appropriate to the material being presented has been used.

My ANT Analysis Diagrams (AADs) have deliberately been left in hand-drawn form to indicate that they are working documents. It is through the thinking and focus required for their creation that benefit is derived.

I will be talking about students. To distinguish young people who are studying at HE level from those who are younger and studying at lower levels (typically at school) I shall restrict the term 'student' to those in HE and use the term 'pupil' for those who are younger, whether they are attending a school, Sixth-Form college or Further Education (FE) college. This will support clarity.

Similarly, I will be talking about A-levels. Usually this is simply intended to refer to those qualifications which can secure university entrance and should be taken to include Access, vocational Level 3 qualifications and so on.

Usage of the terms 'Computing' and 'computing' follows.

1.5 Terminology: What's in a name?

In describing the distinctions and usage of various terms, such as computing and Information Technology (IT), it is important to be aware that consistency and agreement are limited in extent. This is true within the United Kingdom (UK) but usages differ again elsewhere. Indeed, as I will show later, this lack of a society-wide understanding is a significant source of the tensions at the core of this research and problematic for young people making choices. Nonetheless, for readers outside the cognate area, it is important to make some distinctions and provide some indication of the scope of interpretations.

The term 'computing' is often regarded as an umbrella term. To many people, "*to be good at computing*" simply means, "*to be good at using a computer*". However in Higher Education a course entitled Computing is of a very different nature. It is a technical development course: a course which develops expertise in creating new computer systems. Universities offer a wide range of courses in the area of computing with over 40 titles being available (UCAS 2013). All of these computing courses are rigorous and detailed, and may be more technical,

than the skills and knowledge of a super-user. Thus, the very familiarity of the term 'computing', fails to convey to the public in general the core nature of a university programme in computing. Varying, of course, between the different programme titles, a computing course is, in general, about creating new systems and applications for use on computers. In Higher Education a programme entitled Computing is, along with Computer Science, simply one of the most common options. (In Scotland, the term Computing Science is the norm.) These two programmes are highly technical in nature with, almost always, programming forming a core, key thread.

In Britain most schools currently do not teach the subject of computing, or computer science, (see Chapter 2) but rather ICT. The Quality and Curriculum Authority (QCA) describes it thus:

"ICT capability encompasses not only the mastery of technical skills and techniques, but also the understanding to apply these skills purposefully, safely and responsibly in learning, everyday life and employment. ICT capability is fundamental to participation and engagement in modern society" (QCA 2007).

The purpose of this subject is to develop skilled users of computer systems, an essential capability for all contemporary pupils. Recent political changes have led to some very negative rhetoric about school ICT (§2.3, §9.3). However no negative comment about school ICT in this thesis should be interpreted as diminishing the importance of these skills. They matter – a lot.

The delivery of ICT in schools is often characterised as consisting of solely Word, Excel and Powerpoint: the main business software applications (Pau *et al.* 2004, BCS 2011a, NESTA 2011). Indeed, the ICT curriculum does not demand more. However some pupils do get exposure to concepts and skills which are more challenging and analytical, and potentially more interesting and engaging. For example, pupils may be taught some computer programming or algorithm design or a technique to design non-trivial databases or the rudiments of a computer's internal function or logic. But most pupils clearly do not get exposure to this enhanced ICT delivery (OFSTED 2011, NESTA 2011). However the intention of the developers of the original ICT curriculum was that it should

provide a flexible, variable and broad range of experiences across the whole area of computing (Royal Society 2012). Sometimes ICT is used as the umbrella term, covering all areas related to computing (for example, McChesney and Alexander 2006b). Within the British HE computing community the term ICT would, generally, be interpreted as referring to user skills as delivered through the typical school curriculum. There are however few universities which offer a degree with that title. The Royal Society identified five distinct ways in which the term is used (Royal Society 2012). Internationally, ICT is sometimes used to refer to the entire discipline (for example in Australia (Clayton, Beekhuyzen and Nielsen (2012)).

The term IT further confuses the picture. In the UK IT is the umbrella term widely used to refer to the physical computing and networking infrastructure; it is broad including, say, mobile devices. It is also the term frequently used to refer to relevant employment. In recent decades someone is more likely to say that they "*work in IT*" than that they "*work in computing*". Indeed, when the British Computer Society (BCS) went through a re-branding process in 2009 they changed their official title to '*BCS: The Chartered Institute for IT*' in order to encompass that usage. IT is often used in other countries as the umbrella term for the entire discipline (for example in the United States (US), Kvasny, Joshi and Trauth (2011) and Lang (2012)).

Information Systems (IS) is a term sometimes used to refer to specific types of specialised computer systems, such as Health Information Systems. More commonly it is taken to mean systems of interconnected computer-related components, developed to provide a service or function, usually in some business context.

Thus the terms computing, ICT, IT and even Computer Science, are each used as overarching terms, in different contexts. The consideration of this confusion was one feature of a recent Royal Society report (2012) on '*Computing in Schools*'. Some of the other findings of this investigation will be discussed later (Chapter 2), however a prime recommendation was that this matter must be addressed. This confusion, coupled with negative connotations associated (by

some) with the term ICT, led the Royal Society to recommend that ICT should be replaced in schools by three separate subjects of Digital Literacy, IT and Computer Science. If the curriculum were reorganised in this way then schools could ensure that all pupils had well-developed digital literacy, with adequate computer skills to allow them to be fully-productive citizens. This should be seen as an absolute essential for all pupils: *"the analogue to being able to read and write"* (Royal Society 2012:10). Also, all pupils could be given some exposure to both IT and Computer Science and, if they enjoy them, could choose to study them further. By disaggregating such a broad range of topics pupils, and thereby the public, can be made aware that computer science is not the same as IT. Even if they are not clear exactly what the difference is, seeing them as separate subjects would help to alert them that they are. I will discuss the government's response to this later (Chapter 9).

As shown in Figure 1-2, in this thesis I will adopt the widespread convention of

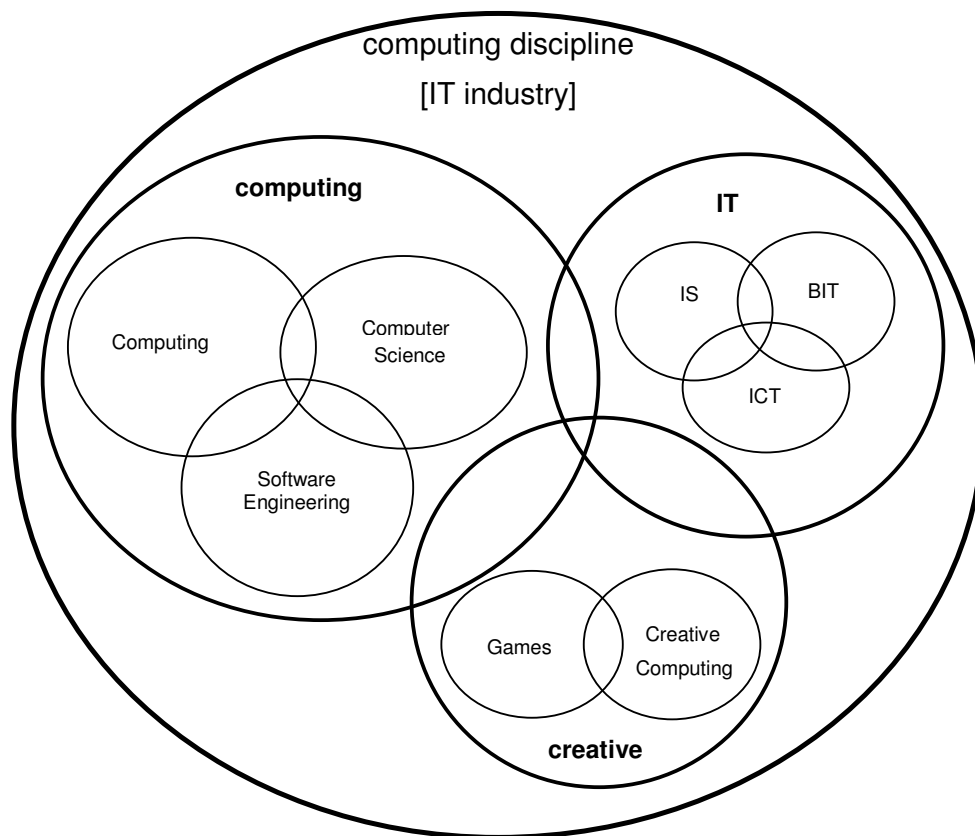


Figure 1-2: Usage of terminology

using IT (or Information Technology and Telecommunications (IT&T)) when referring to employment. I will use ICT to refer to the study, such as in British schools, of how to use pre-existing computer systems and Computing (upper-case 'C') to refer to a qualification or course. I shall be adopting the convention of using computing (lower-case 'c') to refer to that part of the discipline which focuses on technical systems development, including Computer Science, Computing and Software Engineering, and which forms the focus of this work. Courses which are of an imaginative and artistic bent, such as Games Technology and Creative Computing, are grouped as 'creative' courses. In addition, the discipline encompasses specialist courses, such as Ethical Hacking and Artificial Intelligence. In line with the Royal Society report, I will also use 'computing' to refer to the whole discipline, encompassing computing, ICT and IT, although I will qualify this usage when necessary to ensure clarity.

1.6 Scope

This project was designed to investigate issues related to influences on, and perceptions of, students enrolled on (or pupils aspiring to) technical, non-specialist computing courses in Higher Education in England. The courses involved are those just described as being a 'computing' course and might be entitled Computer Science or Computing or perhaps Software Engineering. Students on, or pupils aiming for, these courses form the core of the area of concern. The content of such courses varies between institutions but they will all be highly technical and development-focussed with a significant element of programming. (Issues to do with the inconsistent naming of such courses are discussed later (§2.4.1 and §8.3)).

However as will be described later (§4.4.5), it proved impossible to restrict data collection to students on such courses. Similarly it was impossible to restrict pupil participation to those aiming for these titles since, inevitably, school pupils are still in the process of making course choices. Nonetheless it was issues related to these core, technical 'computing' titles which were of interest. Students who are enrolled on a specialist degree or a 'creative' computing

degree or a more business-focussed degree such as BIT may well have different views, interests and perceptions. By focussing on this small group of similar courses confounding factors between courses were minimised.

The project aimed to consider issues from the view of UK educated students since the context and perceptions are likely to differ in other countries. Beyond that the project aimed to be inclusive of all ethnic groups, ages and genders. The project focussed on full-time students only, since part-timers typically have different background and motivation, although this was not significant since Coventry currently has no part-time provision. These scoping and eligibility issues are discussed more fully in §4.4.5.

1.7 Where am I going?

Having contextualised my study I must now introduce my thesis. Chapter 2 follows and describes the background to computing education. I will discuss the state of computing in schools, universities and employment, identifying some of the current problems, challenges and concerns. I will describe how the IT industry reports a severe skills shortage and yet computing graduates have some of the worst levels of graduate unemployment of all disciplines; the poor progression rates of computing undergraduates through their degrees; and the changes over recent years in the popularity of computing degrees. As well as presenting the 'facts of the matter', I shall review existing research into these phenomena. As I will note, there has been very little qualitative research to really try to understand some of these issues.

I will then present a description (Chapter 3) of the conceptual framework which informed my analysis. The rationale for my selection is provided later (Chapter 4) but at this point I provide a description of my main analytical device, Actor-Network Theory (ANT), and the other main theories employed during analysis: Structure and Agency and the Theory of Social Practice. This is accompanied by a brief discussion of the supporting concepts of Engagement, Motivation, Communities and Identities. Chapter 4 leads on from that with a discussion of

my epistemological and ontological stance of constructivist-interpretivism which underpins my research strategy and methodology, accounts of both of which follow. There I also discuss the stages in my research project and, of course, the methods I selected. I also raise some of the issues encountered during my research work. I provide a brief description of ethical matters here, although I also discuss this important, pervasive concern alongside some of the issues where they were particularly pertinent. Chapter 4 also includes my description of ANT Analysis Diagrams, the novel technique which I derived to operationalise ANT, mentioned earlier. These first four chapters thus set the scene and describe my research process.

In the following three chapters I present my analysis, each focussing on one of the main themes. The first of these, Chapter 5, relates to the image of computing. Here I discuss the potentially negative stereotype associated with computing and what school pupils and computing students know about computing as an area of study and a career option. Chapter 6 follows on from this and here I focus on the processes involved in choosing a university course. Most particularly I discuss the role of the family and school in this and how some pupils can move through their school education almost mindlessly, as though on an educational conveyor belt. I also look at the routes by which pupils might gain an understanding of what the subject of computing is about. However the main focus of this chapter is to consider why some pupils apply for a computing course at university and what they expect of it. I will argue that some students exercise little agency in their progress through their HE course and can be seen as behaving as though they were a Pooh-stick⁴.

In the final analysis chapter, Chapter 7, I move further on through the student's journey to consider their engagement once they have enrolled. I will look at factors in their course which participants identified as being particularly important for them. Then I consider how some students can become disengaged from their course. This leads into an exploration of patterns of disengagement and the characteristics of engagement. I then present three tentative models of

⁴ A.A.Milne (1928) *House at Pooh Corner*. London: Methuen

engagement and conclude the chapter by discussing some of the responses to disengagement. In particular I will identify how some students can be labelled as being disengaged when that is not really an appropriate way to consider their behaviour.

In Chapter 8 I will evaluate how each of my lenses assisted during my analysis. Whilst my research aimed to create a thick, rich description of the domain, gaining a deeper understanding of the processes and dynamics at play there are new understandings which I have created, which I then pull together, identifying my theoretical contributions in this area. In the final chapter, Chapter 9, I address the broader implications of my findings. First I consider implications concerning the profile and image of computing and some of the related systemic issues. Then the changes planned for schools in England are considered, appraising some of their potential impacts. There are implications for computing degrees, and particularly their recruitment, which I also present. These discussions give rise to a number of implications for the range of computer education stakeholders which are also presented. My thesis concludes with an evaluation of, and reflections on, my research.

2 : The World of Computing

Age range	School years	National Curriculum Key Stage	Typical qualifications	Typical qualification level
5-7	1-2	KS1		
7-11	3-6	KS2		
11-14	7-9	KS3		
14-16	10-11	KS4	GCSE	level 2
16-18	12-13	KS5	A-level	level 3

Table 2-1: Structure of the educational system in England

2.1 Introduction

This chapter sets the scene for this research by presenting some issues and previous research concerning computing courses in English Higher Education Institutions (HEIs). However in order to understand the situation in universities it is also necessary to look at schools, since students' prior experiences there influence them as they progress into higher education. In fact, it seems that most pupils currently get no exposure to technical computing topics at school. The world of work in IT is also significant since there are difficulties related to a shortage of skilled IT staff, and yet graduates find it hard to gain employment. Perceptions of such matters will influence computing's appeal as a potential career. By summarising previous research it will support subsequent consideration (in Chapters 5-7) of young people's perceptions of some of these issues. Research related to recruitment difficulties, poor graduate employment and student progression and weak student satisfaction of technical computing students, is mainly quantitative in nature, and indeed even that is scant, particularly in the UK. The current work, with a qualitative approach, was designed to deepen the understanding of the dynamics of the processes at work.

However this trail through the world of computing will start by summarising salient issues in the current political context. This will provide the context for this project, introducing some of the main issues. Attention will then focus in, presenting the position of computing in English schools and then the recruitment to computing as an HE subject. Some of the issues related to structures in IT employment are then described. The chapter finishes by summarising previous research into the three areas which will form the main themes of this thesis: the image of computing, the process of choosing computing and engagement of computing students.

2.2 The Political Context

Over the last few years several bodies have been campaigning for a reformation of school computing. As will be described this is currently leading to significant

changes. Indeed it is difficult to challenge the suggestion that: *"the pace of change being observed is unprecedented"* (Sentence 2012:1). Although concern about the decline in numbers of computing graduates has been expressed for some time (for example, CPHC 2008b) recent developments have been triggered largely by three main events: a speech by Schmidt of Google and publication of reports on the state of computing by National Endowment for Science, Technology and the Arts (NESTA) and the Royal Society. These will be introduced shortly.

Computing At School (CAS) is a grassroots working group which was instrumental in the commissioning of the Royal Society report. Supported by industry, it is working to develop the teaching of computer science in schools. Its prime aim is to ensure that all school pupils have some experience of computing, as well as ICT. Since its launch in 2008 membership has grown extremely rapidly (Figure 2-1) and at the time of writing (September 2013) it has reached almost 6000. 70% of CAS members are school teachers although they include academics, parents, governors and people who work in IT (CAS 2013c).

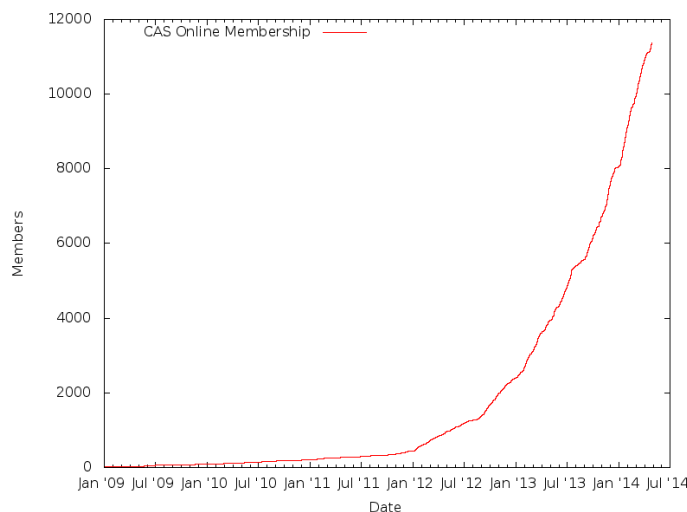


Figure 2-1: Computing At School membership
(CAS 2013a, with permission)

The NESTA 'NextGen' report was commissioned, by the government, to investigate employment problems in the visual effects and video games

industries (NESTA 2011). It considered the development of computing skills along with design and artistic ones. They believe that the UK is falling in the world rankings of these industries and attribute this to a lack of:

"job-ready graduates with... specialist technical skills who can start with a good understanding of production processes and the programming languages and software applications the industries use" (NESTA 2011:5, emphasis added).

NESTA attribute these recruitment problems as starting with the lack of exposure to computing in schools but also to *"poor university courses"* (NESTA 2011:5). They expand this, referring to courses presented as being specialist but which fail to properly equip graduates for specialist employment. To address this weakness NESTA suggest that the Skillset accreditation of Games courses be strengthened. However only 12 of the existing 104 (UCAS 2013) Games (and related) university courses actually meet the current standard (Creative Skillset 2012), so the Skillset accreditation standards themselves may not be entirely the reason for poorly equipped 'creative computing' graduates. This NESTA report was based on the premise that a university degree should train graduates so that they are immediately ready to be fully productive employees. Their critique is specifically of courses presented as specialising in the areas of video games and visual effects, not of computing courses in general. They recommended that computing, as opposed to ICT, should be given more emphasis in schools.

Shortly after the publication of this report Eric Schmidt, Executive Chairman of Google, gave a highly publicised lecture (Schmidt 2011), in which he criticised the state of computing education in Britain.

"I was flabbergasted to learn that today Computer Science isn't even taught as standard in UK schools. Your IT teaching focuses on how to use software but gives no insight into how it's made" (Schmidt 2011:8).

In parallel with these events the Royal Society launched an investigation into the state of computing in schools. In August 2010, motivated in part by a national shortage of computing skills, they started to investigate school computing. As their final report says:

"the project was prompted by a high degree of concern... about aspects of the current provision of education in Computing in UK schools. That such concern had been expressed by so many with such different perspectives – including in schools, in business and industry, and in universities – was indicative of a significant problem" (Royal Society 2012:5).

They requested evidence for consideration and received submissions from many interested parties⁵.

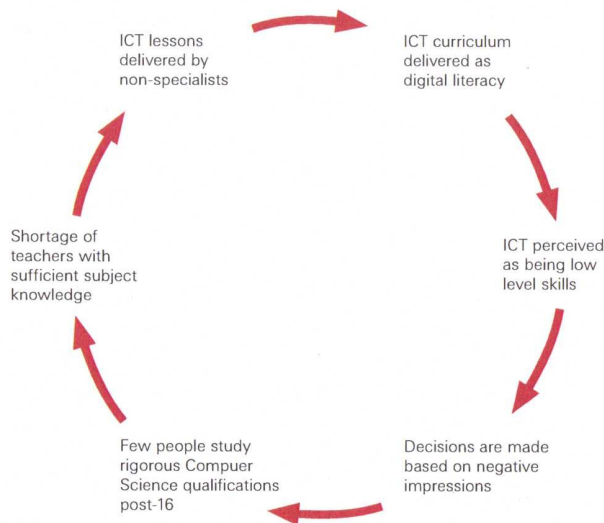


Figure 2-2: The *Status Quo*

(Royal Society 2012:7, with permission)

At the core of their report is the identification of a cycle of influences (Figure 2-2) which serve to maintain the *status quo*. It highlights that differing contexts and usages of terminology (§1.5) have created a negative cycle, based on misunderstandings. Their recommendations seek ways to break this, in order that stakeholders' interests can all be advanced. Their analysis is open to some critique however. They are implying that A-level ICT and equivalent qualifications are not rigorous, which might be contentious. Also, many students take a computing degree (§2.4.2) even though there are only a few who take Computing A-level (§2.3). Their analysis is premised on the assumption that a CS degree is needed to teach school ICT as a stimulating subject. Since there is

⁵ The results of the preliminary study of the current research were submitted for their information.

limited overlap in content, the possession of a CS degree cannot be necessary to deliver school ICT in a stimulating manner. Where delivery is less interesting it could be due to the teacher's lack of subject knowledge but this cannot be gauged by whether or not they possess a CS degree.

They make two fundamental recommendations. Firstly that computing should be introduced as a core element in the school curriculum. Secondly that the terminological confusion should be addressed and schools should deliver computing as three separate subjects: Digital Literacy, Information Technology and Computer Science (§1.5). The most important impact of this would be that all schools (both secondary and primary) would need to deliver CS content, alongside ICT. Since pupils' experiences of computing at school affect their interest in pursuing it in HE, the current position of computing in schools will be explored next.

2.3 School Computing

In England the school curriculum currently includes the subject of ICT. In maintained schools, which are subject to the requirements of the National Curriculum, it is taught as part of the core curriculum to all pupils, up to age 14, and is a compulsory foundation subject for ages 14-16 (DfE 2012). Also, it is available in most schools as an option for study for General Certificate of Secondary Education (GCSE) and A-level and equivalent qualifications. (The correspondences between age ranges, Key Stages (KS) and typical levels of study are provided as Table 2-1.)

In recent years there has been a range of GCSE-equivalent (level 2) ICT qualifications which have proved very popular with schools and students. Nonetheless ICT has a very mixed reputation. Anstead (2010) suggests that much ICT is not very demanding and fails to stretch bright pupils. Mike Short, the President of the Institution of Engineering and Technology, asserted that the ICT syllabus was 20 years out of date:

"The current school ICT syllabus is not appropriate for the digital generation since it does not equip our young people to be able to understand or compete in the modern world" (Rochdale Online 2012:unpaginated).

The view of the Office for Standards in Education, Children's Services and Skills (OFSTED) (2011) was that ICT in under half of secondary schools was good or better. Nonetheless, some pupils really enjoy their ICT lessons and are keen to do more. For example, a BCS (2005) study of the attitudes of girls taking a mix of GCSE and A-level ICT, found that two-thirds enjoyed these lessons. Other studies, such as Council of Professors and Heads of Computing (CPHC) (2006), found that some GCSE students reported their ICT to be mundane, boring and lacking challenge, although those taking it at A-level were much more positive.

The position of Computing in schools is very different. Although computing has been taught in some schools in England since at least 1969 (Clark and Boyle 2006), to widely varying extents, it is currently not identified as a separate subject in the National Curriculum. Some pupils do get some exposure to some elements of computing though, perhaps as algorithm development, flowcharting or programming. Sometimes this is delivered as part of the Mathematics or the ICT curriculum (§1.5). However most pupils currently get no exposure to any technical computing at school.

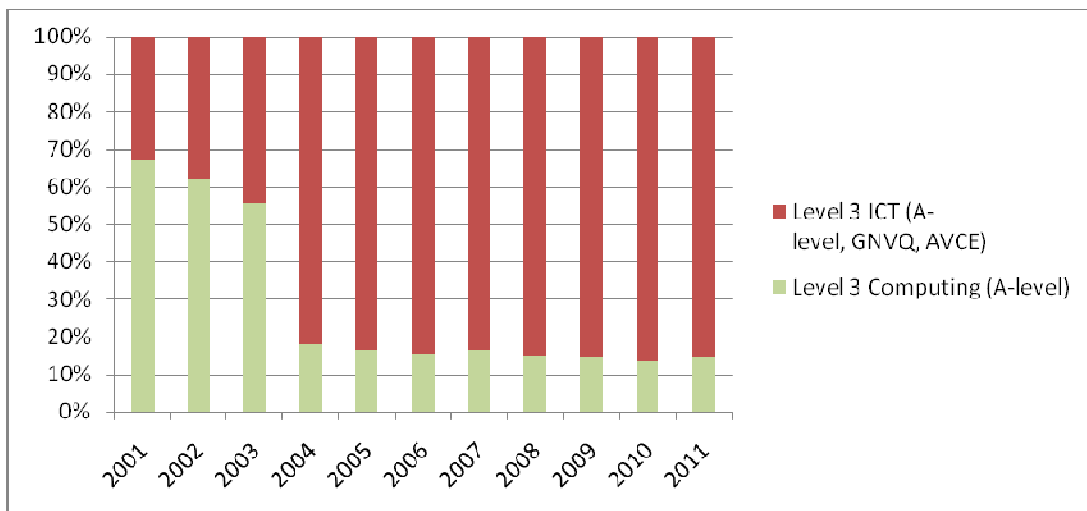


Figure 2-3: Level 3 examinations in Computing and ICT, in the UK

(JCQ data via Royal Society 2012. N ranges 27,840-50,677)

At A-level (and level 3 equivalents) the position is one of a declining uptake of Computing. Since qualification reforms in 2004, a fairly constant 14-18% of qualification attempts in the computing discipline have been in Computing, as opposed to ICT (Figure 2-3). Only 0.6% of all A-level candidates take Computing (Bishop 2010). Entries have fallen from 21,744 in 2001 to only 4,002 in 2011. Over the same period the total number of examination entries in the computing discipline has fallen by 14% from 32,388 to 27,840 (although peaking at 50,677 in 2003) (Royal Society 2012). It is not known what proportion of schools offer Computing A-level, but it is clearly very small⁶. The detailed data related to examination attempts are available from the Joint Council for Qualifications (JCQ) (2012).

There is a serious under-representation of women at all levels of computing (§2.4.2, §2.5.2) and, whilst not a focus of this research, the scarcity of females in computing is too significant to be entirely ignored (§4.4.5). The number of female A-level Computing candidates has fallen even more than males, from 14% of entrants in 2002 to 8% in 2011 (Royal Society 2012), compared with over 25% in the early 1970's (Clark and Boyle 2006). By contrast, between 2002 and 2011 the proportion of female ICT A-level candidates rose from 35% to 39% (Royal Society 2012).

Until very recently Computing was not available as a GCSE. However the recent campaigns mentioned earlier (§2.2) have led to change: the first GCSE being launched in September 2010 (Bishop 2010). These qualifications are not entirely novel though. Through the 1970's and 1980's General Certificate of Education (GCE) O-level and then GCSE qualifications were available in Computer Studies (Clark and Boyle 2006, Royal Society 2012). An Her Majesty's Inspectors (HMI) survey of Computing as a specialist subject in schools during 1987-9 concluded that: *"the study of Computing can and should be stimulating and fascinating for pupils. As experienced by many, it is sometimes dry, dull and unexciting"* (HMI 1990). To address this, over the following few years Computing was replaced in

⁶ 4000 entrants per year, spread over c4000 secondary schools, with an average class size of say 10 pupils, suggests fewer than 1 in 10 schools.

schools by IT, then ICT, evolving into the curriculum that we have in schools today.

The Royal Society considers the low uptake of Computing A-level as being, in part, a result of *"a lack of demand from HE"* (Royal Society 2012:12). The report suggests that HE does not focus on Computing A-level as an admission requirement due to *"serious concerns about a mismatch of curriculum with universities"* (Royal Society 2012:68) and asserts that this mismatch resulted in many universities focussing on candidates' mathematical ability. No evidence is presented for this asserted causality and, whilst some universities do seem to feel that Computing is not a useful A-level for admissions purposes, this is only a partial explanation. Other factors include: the requirement for students to have a solid mathematics background; the scarcity of A-level Computing students and the competencies of students with this Computing qualification. These will be explored further, in turn.

Firstly, the Royal Society (2012) collated the entry requirements of computing courses in the UK. No HE course required Computing as an entry requirement, although some courses do specify A-level Mathematics, and some include Computing as one of a choice of essential or preferred subjects. Advice issued by the Russell Group (2012) universities presents Mathematics very clearly as being the more useful subject. In some universities this is a necessity because their curriculum is very mathematical in nature and students need this preparation; in other universities mathematical ability is seen as a proxy which gauges the students' potential for success by assessing their ability to think logically. Research exploring this is presented later (§2.8).

Secondly, since universities do not require Computing for entry, but some do require Mathematics, many pupils and schools see Mathematics as a better, more-flexible A-level option. Thus there is a diminished demand for A-level Computing. There might be benefit in breaking this cycle (Figure 2-4).

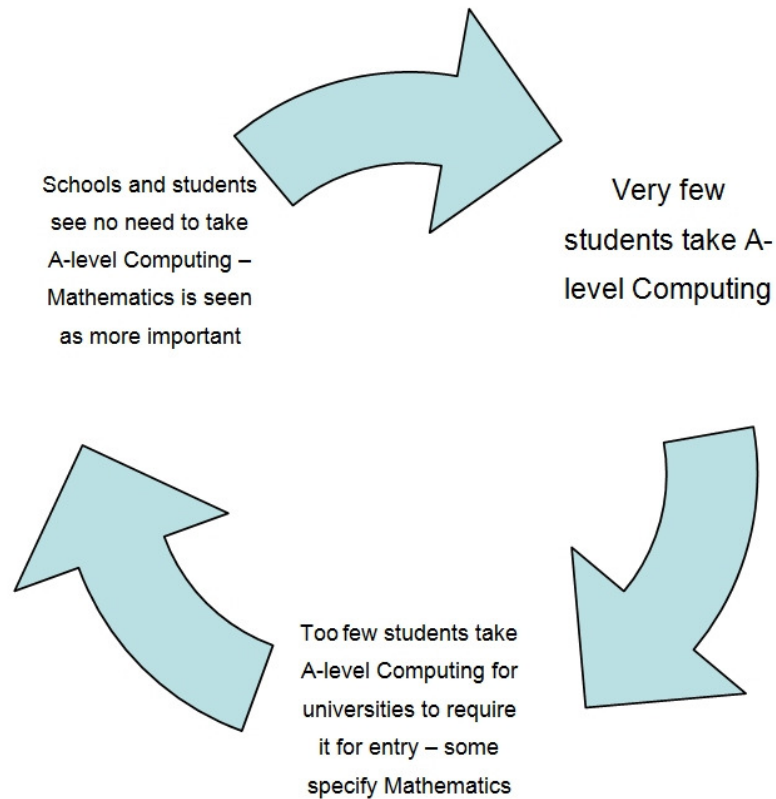


Figure 2-4: The Higher Education conundrum

So few students take A-level Computing that to request it for admission would seriously diminish the pool of eligible applicants. Computing courses in HE are a relatively popular option (c10,000) (§2.4.2) compared with A-level Computing (c4,000). This creates a chicken-and-egg situation. Few schools offer it and therefore few pupils have the opportunity to study it but if A-level Computing is not a University entry requirement, schools are unlikely to see a demand to offer it (although this may change, as described in Chapter 9). Very recently some universities have been considering their role in this cycle. One has changed its entry requirements.

"We particularly welcome applicants who have studied Computing at GCSE and/or at A-level, and can be more flexible if you have done so. However, study of Computing at school is not a requirement at all. Likewise, we welcome Mathematics A-level, but do not require it"
(University of Kent 2013:unpaginated).

This is broader than their previous guidance, that Mathematics is useful.

Thirdly, it is not clear that universities will generally favour students with a Computing A-level (even if the student has one or more Mathematics A-levels alongside). Universities see it as their responsibility to teach students to adopt 'good practice' and abide by certain standards and approaches. When students with Computing A-levels were more commonplace, say two decades ago, universities often expressed concern about the difficulty of needing to get students to un-learn bad habits which they had adopted. If A-level content and delivery were felt to be useful by universities then more may start to give priority to these students. However, as will be seen, university courses are so very variable that the A-level syllabus is unlikely to align well with them all.

Nonetheless it may be perceived as being useful because such students would at least know what a Computing course is about. Thus the position of the subject in schools is that pupils study ICT and most can choose to take qualifications in it. By contrast most pupils get no, or only very limited, exposure to any aspect of Computing (Clark and Boyle 2006) and most get no opportunity to gain qualifications in it. As will be explored later (§2.7), most pupils do not know the difference between these subjects.

The problems of limited exposure to the basics of computing are mirrored elsewhere in the world. For instance, in the US (Yardi and Bruckman 2007a) and Germany (von Hellens *et al.* 2009) pupils do, of course, have classes in computer usage but, as in the UK, these may only look at a computer as a tool and teach the use of applications. For example, pupils may pass through their schooling and get no experience of programming, algorithm development or system analysis and design. In the UK, as in the US there is reported to be a shortage of computing expertise amongst school teachers (Yardi and Bruckman 2007a).

In addition to concerns related to school pupils' lack of exposure to computing there were also concerns about its quality, which led to consideration of these teachers' qualifications. The NESTA report noted the low number of teachers who are qualified in Computing:

"Of the 28,767 teachers who were awarded Qualified Teacher Status [QTS] passes and registered with the GTC in 2010, only three qualified in computing or computing science as their primary qualification (compared with 750 in ICT)" (NESTA 2011:39).

This means that very few new teachers, if they chose to register with the General Teaching Council (GTC), specify computing or computing science (or computer science) as their specialism. However this is not an accurate reflection of the number of computing graduates who enter the teaching profession⁷. Whilst there are not many school teachers with computing degrees, there are not so very few, as was confirmed by a Department for Education (DfE) teacher census (see Appendix F.1). The Royal Society recognised that this represents a serious shortage of trained teachers if more Computing is to be taught.

However, the low numbers of teachers who are qualified in ICT cannot be helping the delivery of that subject either (BCS 2011a, Royal Society 2012). Whilst not suggesting that only people with a relevant qualification can be good teachers (industrial experience or a hobby interest can serve well) the extent of the unqualified must play a part in why so much ICT teaching is deemed boring and uninspired. The Royal Society acknowledges that there is a substantial need for CPD (Continuing Professional Development) to retrain and refresh Computing and ICT teachers.

There are a few keen teachers, maybe computing graduates, who are well-able to deliver more exciting and challenging material but who report many barriers. The constraints of the National Curriculum have been problematic, although these are in the process of being addressed (Chapter 9). These teachers often experience restrictions and limitations in both the school IT infrastructure and the teaching resources to which they have access (Royal Society 2012). CAS is very active as a support network helping these enthusiastic teachers share materials and ideas helping all computing teachers make positive changes

⁷ However this finding has been mis-read and widely misquoted as saying precisely that (for example, BCS 2011c, Guardian 2012b). If this were true it would be a remarkable situation and, as a consequence of its power, this mis-reading has been widely disseminated. It has been treated as accepted fact by key people and has become an urban myth. In order to support the attempt to correct this misunderstanding the investigation undertaken to clarify these statistics is documented in Appendix F.2.

(§2.2). Their discussions have provided a useful window into the views of, and issues faced by, these active school teachers of computing or ICT.

Thus, currently, many schools have little computing expertise and most pupils in England get to the end of their school education having not been exposed to technical Computing and could confuse it with ICT. As will be described (Chapter 9) all schools will soon be expected to teach computing, but as has been shown, there is limited expertise in schools. For those pupils who are interested in studying computing at HE, universities send very mixed messages about the benefit of taking A-level Computing. But, nonetheless, these are the pupils from whom universities aim to recruit their Computing undergraduates.

2.4 Computing in Universities

Computing is a very broad discipline (§1.5) but, within that, subject experts have long debated what even the core subject of Computer Science is about. However they would all probably agree with a light-hearted, oft-repeated, comment from Mike Fellows that: "*Computer Science is as much about the study of computers as Astronomy is about the study of telescopes*" (Parberry 2011:unpaginated)⁸. The computer and the telescope are largely just tools of these respective subjects and, in both contexts, some useful work can be done without them.

In a seminal paper, provocatively sub-titled: "*On the Cruelty of Really Teaching Computing Science*", Edsger Dijkstra describes CS as: "*concerned with the interplay between mechanized and human symbol manipulation*" (Dijkstra 1989:1401). It is about computational systems. This would naturally lead to courses which are highly mathematical in content and character. Dijkstra acknowledged that many universities felt that: "*if it has to teach formal mathematics to CS students it may as well close its schools*" (Dijkstra 1989:1402). This view was a reflection both of many students' inability to cope

⁸ Often mis-attributed to Dijkstra

with this material but also of the expectations of many stakeholders, including students and employers.

Professor Chris Bishop, Vice-President of the Royal Institution of Great Britain, described CS more pragmatically and much more broadly, as:

"[dealing] with the foundational concepts that underpin digital technology, including how computers are built, how they work and how they are programmed. It is a rich academic discipline that intersects mathematics, physics, engineering, technology and social science" (Bishop 2010:unpaginated).

As described earlier (§1.6), this project focuses on issues related to technical, development-focussed computing courses, particularly Computer Science, delivered by HEIs in England. Previous investigations into the state of computing in universities have adopted diverse scopes. Many studies have encompassed courses in any area of computing; some embrace joint courses too and some studies are located in Business Schools, focussing on business-facing computing courses. However it is technical development computing students (characterised as Computer Science) which are of prime concern here. The aspects of interest are: course content, student recruitment, non-progression, student satisfaction and graduate employment. The position of each, as related to core computing students, will be described in turn, focussing particularly on the UK. Much of the previous work has been quantitative in nature looking for trends, patterns and causalities, deduced from various statistics. There have been only a few qualitative studies which try to 'get inside' and really understand the issues at play. This previous research will be presented later, organised by the emergent themes of image, choice and engagement (§2.6-2.8).

2.4.1 Course content

HEIs in the UK offer a diverse range of computing courses (§1.5). The Quality Assurance Agency (QAA) Computing Benchmark Statement (QAA 2007) specified the range of possible areas which a computing programme might cover. It is huge and allows for degree programmes with foci as diverse as Software Engineering, Artificial Intelligence, Games Programming, Human

Centred Computing, Business Information Technology (BIT) and Computer Networking. These are all accepted by QAA as lying within the cognate area of computing. Most courses will also be very technical but, particularly, there may be no need for all students to have any exposure to computer programming. Programme designers are likely to see some programming as being a necessity for networking specialists, say, but may take a different view for BIT or Human Factors courses. These programmes will develop detailed, specialist knowledge which may be less technical than that in, say, Computer Science but even these still require understanding and knowledge of a very different nature from that of 'a skilled user of computers', a super-user.

The content of Computer Science courses vary widely. Indeed: *"it is very hard to identify syllabus parts common to all programmes"* (Boyle, Carter and Clark 2002:5). Some are highly practical but others much less so (Boyle, Carter and Clark 2002). It may vary from something akin to applied mathematics at one extreme to those where there is very little overt mathematics. A course entitled Computing at one institution may be very similar to one called Computer Science at another. Of course, any programme accredited by a professional body, say the BCS, does ensure some minimal content coverage (BCS 2010a). Thus, when authors comment on the content of courses, even those titled Computer Science, they will, to varying extents, be considering diverse courses.

The provision of specialist courses, such as Computer Games Technology, has mushroomed in recent years, capitalising on emerging markets. Some of these specialist courses include the core computer science concepts and can be seen as a specialist variant of CS but others may be much narrower, such as Computer Security. Computing is usually seen as a vocational discipline so course developers are aware of the employment implications and endeavour to design courses which lead to employable graduates, often consulting employers in the process.

2.4.2 Recruitment

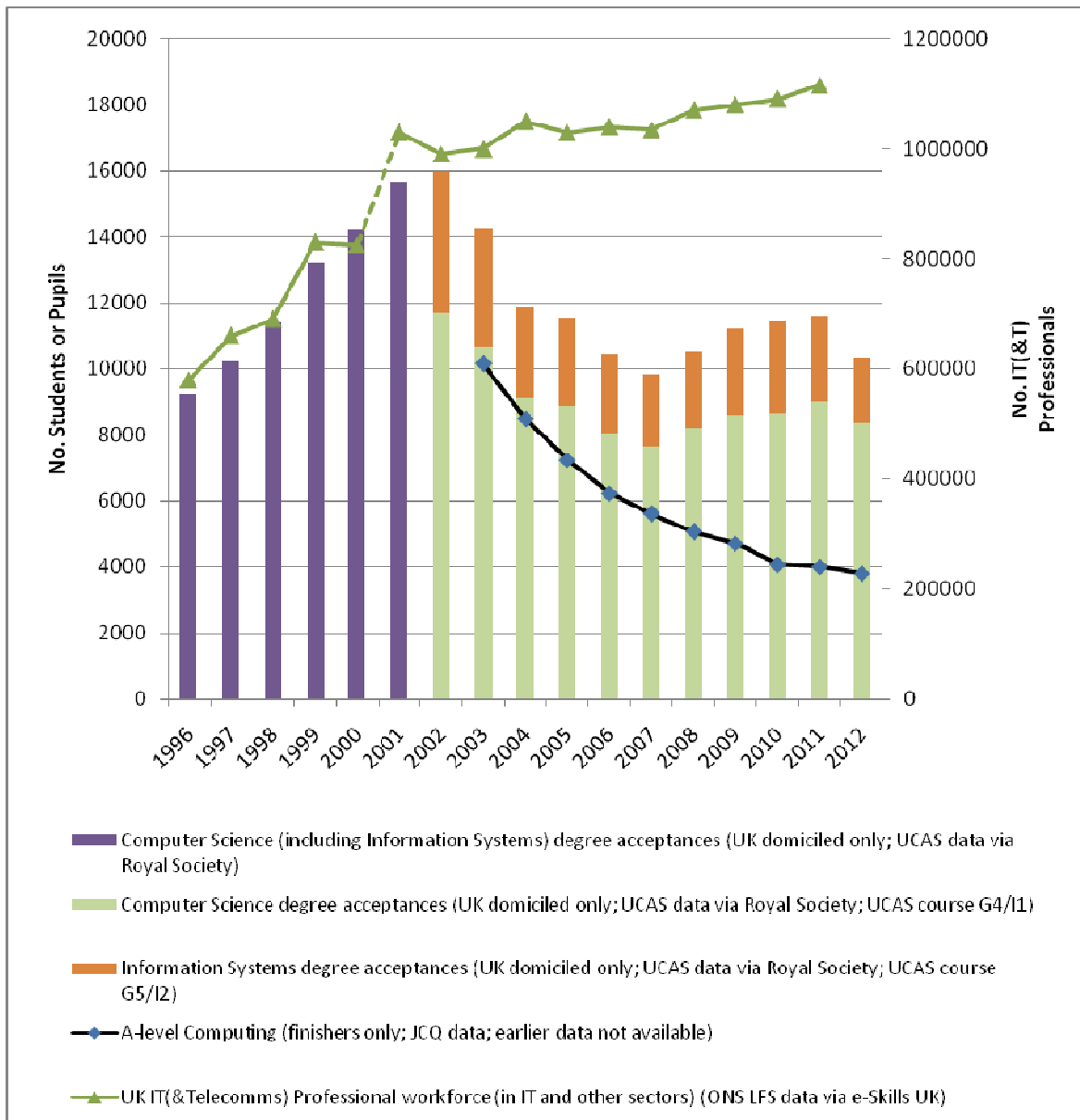


Figure 2-5: Trends in computing⁹

Recruitment of students onto HE courses has periodically been of concern. Sometimes this has been due to employers reporting recruitment difficulties,

⁹ There was a change of coding of Office for National Statistics (ONS) workforce categories in 2001 and of UCAS degree titles in 2002

finding it hard to fill their places with suitable candidates. Considering acceptances onto Computer Science degrees, there was steady growth from 1996 to 2001 (Figure 2-5). Even allowing for data re-coding in 2002¹⁰, there was a decline until 2007 which caused much concern to the IT industry both in the UK (for example, CPHC 2008b, BBC News 2006) and elsewhere (Alexander *et al.* 2011, Kral and Zemlicka 2008, Lovegrove and Round 2005). Enrolments on some US computing courses fell by 60% over the 4 years from 2002 (Carter 2006, Guzman *et al.* 2008, McGettrick *et al.* 2007).

The strong growth was at a time when the internet was starting to be used in many new ways. However the dot-com crash in 2001 seemed to lead to a 'reality check' and a sharp decline in applications (Bishop 2010). Concern about the decline was so great that the 2007 SIGCSE Conference held a crisis discussion (McGettrick *et al.* 2007). The briefing paper issued ahead of this session suggested that the factors behind this decline were: the perception that the dot-com collapse and off-shoring had eliminated computing jobs; negative perceptions of the nature of computing jobs; poor public understanding of the scope of computing; lack of diversity of the workforce, attracting few women or minorities; few opportunities for pupils to experience computing; concerns about the relevance of some material taught and a lack of excitement and currency of much of the undergraduate curriculum. These explanatory factors were presented as being realities although limited evidence was offered. There appears to be no public record of the ensuing debate. However some, if not all, of these factors are, in reality, much more nuanced. Many of them are considered in the current project. Previous research into why students choose computing courses is discussed later (§2.7).

By 2011 there had been some return of interest, recruitment returning to the levels of the late 1990's, perhaps due to an interest in developing mobile apps (Bell and Corner 2011). In 2012 there was however a 7% dip in recruitment (THE 2012b). In part this is a reflection of the decline across all subjects, resulting from significantly increased tuition fees. Viewed as a proportion of all

¹⁰ This separated Information Systems off from Computer Science.

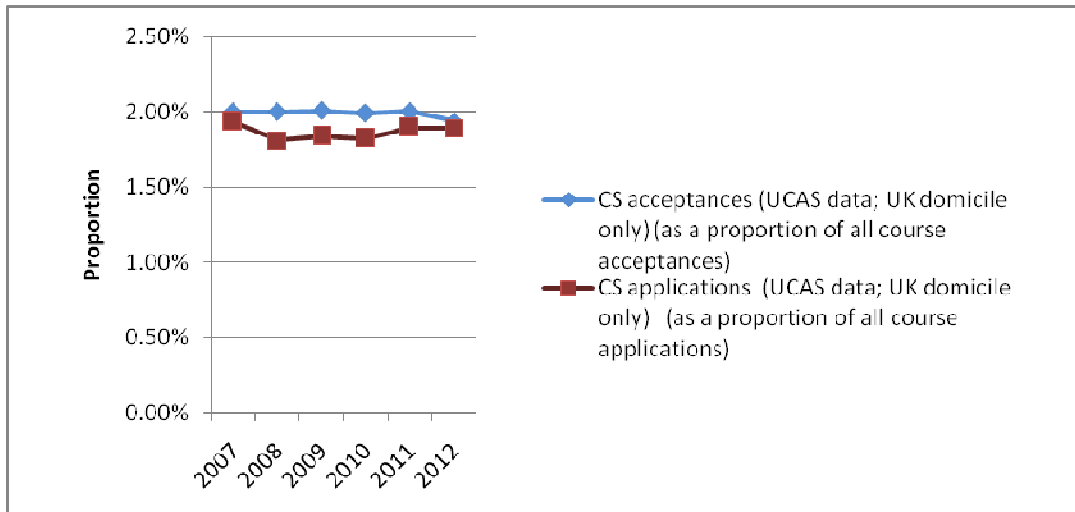


Figure 2-6: CS applications and acceptances

course applications or of all acceptances, the position of Computer Science has remained fairly constant (Figure 2-6). (Unfortunately the available Universities and Colleges Admissions Service (UCAS) data are limited to the last 6 years.) The difficult employment situation nationally since the financial crash in 2008, will have caused some students to look for a course where they perceive employment prospects to be good. IT employers' recruitment difficulties have received significant publicity – but so too has graduate unemployment. There has also been some resurgence of interest in the US, in part attributed to revised curricula (New York Times 2011), with increases in recruitment of 5.5% in 2008 and 8.5% in 2009 (White 2010).

Although not a prime focus of this research the ongoing, long-term decline in female participation is a significant concern. In 2010 only 18% of graduates from IT and Telecoms (IT&T) HE courses were female¹¹ (e-SkillsUK 2012); this has fallen from 23% in 2003 and 20% in 2007 (e-SkillsUK 2009b) and is continuing to fall (e-SkillsUK 2012). 15% of both applicants and acceptances were female in 2007, indicating that females are as likely as male applicants to gain entry, if they

¹¹ HESA 2010 data

apply¹² (e-SkillsUK 2009b). As will be described shortly (§2.5.2) this trend of declining female participation is mirrored in the IT industry. Females represent a large pool of potential talent, if only they could be attracted into the subject.

There has been a wide range of *ad hoc* initiatives, from many sources, aimed at giving school pupils some exposure to computing, so that they can make better-informed career choices and some individual schools run Computer Clubs.

These projects vary in their objectives and target audience. Examples include '*Hack to the Future*' school-based experience sessions; CC4G (Computer Clubs for Girls); Geek Girls courses and Technocamps (CAS 2012a, CAS 2013b, CAS 2013d, Cutts *et al.* 2007, Woman's Hour 2013). Such initiatives may all be worthy, but they each have a small reach so even collectively they cannot make great impact on exposing all pupils to technical computing. Digital initiatives, such as the CS4FN (2013) magazine and '*Behind the Screen*' (e-SkillsUK 2011), have the potential for a wider reach. Universities, of course, also take a role in increasing exposure to computing with many running experience days, summer schools, competitions and the like, in addition to informative marketing activities such as Open Days, Careers Fairs and schools visits. These must help too, but nonetheless it seems probable that most pupils do not get access to any technical computing experience. This will be shown to be significant when considering how pupils choose courses (Chapter 6).

2.4.3 Attrition and non-progression

Student drop-out and attrition in computing courses are high and have long been a cause for concern. They have been reported as reaching 30-50%, across all three years, in some HEIs (McGettrick *et al.* 2005). The Royal Society suggests that:

"Computer Science... suffers from a high first-year attrition rate – possibly as a result of students arriving without a clear understanding of what Computer Science is" (Royal Society 2012:12).

First-year non-progression is worse overall in Mathematical and Computer Sciences (11.9%) than all other subject areas (9.2% on average)¹³ (NAO 2007).

¹² UCAS data

The Royal Society commissioned an analysis of the non-progression of students from the first year of HE computing courses in 2008/9 (Royal Society 2012) which confirmed that attrition rates are higher for computing courses than other subjects. The raw drop-out data show that computing is higher than Mathematics or Physics (9.7% of enrolling first-year computing students have left HE entirely by the end of their first year), but is comparable to Engineering and Technology. The analysis also shows that it is quite common for students to change course and continue on a related computing degree. Including these gives a non-completion rate for that one year of 19.2%. Whilst it seems probable that some students do fail or leave their course as a result of mis-aligned expectations the report provides no evidence to support this explanation. It would seem probable that there are several other reasons involved in this attrition, including the poor development of the necessary aptitudes, such as rigorous logical thinking and persistence, in addition to typical generic issues such as personal and financial problems (NAO 2007). Poor retention of computing students is not confined to the UK. For example, Schulte and Knobelsdorf (2007) report that in Germany computing consistently has the highest dropout rate (at 38% in 2005).

2.4.4 Student satisfaction

Another area of concern for the HE Computing community is the results of the National Student Survey (NSS). The Higher Education Academy (HEA) produced a series of benchmark documents to assist in interpreting these results, for separate disciplines. One compares results from the 10,000 computing students with the 250,000¹⁴ studying other subjects (HEA 2012a). These students have significantly lower overall satisfaction (77.9% satisfied) than students generally (83.3%), but varying widely between institutions, from 56% to 100%. It is much lower in newer, post-1992 universities (75%) than in older universities (82%). Computing students express greater satisfaction than students studying other Science, Technology, Engineering and Mathematics (STEM) subjects on feedback and assessment issues but they are less satisfied

¹³ 2004/5 starters

¹⁴ NSS data from Higher Education Funding Council for England (HEFCE)

with the organisation of their courses. It is interesting to ponder what this represents and if it might reflect dissatisfaction with the course content and a mis-match in expectations. (There is no other NSS question where they could register any dissatisfaction about this.)

Disengagement is clearly related to satisfaction. There seems to have been no significant research on disengagement in computing students. However professional experience shows that students are sometimes disengaged from their studies, to varying extents. Sometimes this exhibits as a complete lack of interest and sometimes they are not interested in some aspect of their course, typically mathematics or programming.

2.4.5 Graduate (un-)employment

Despite recruitment difficulties experienced by employers many computing graduates find it hard to secure employment. The annual Destinations of Leavers from Higher Education (DLHE) survey showed that across the UK, in January 2013, 14% of the previous year's computing graduates were still unemployed, the worst of any subject area (*cf.* 9% average) (HESA 2013). This has risen from 10% in 2007 (*cf.* 8% average) (THE 2012a, Royal Society 2012), like many sectors having, at least in part, been adversely affected by the financial crisis of 2008. Only 43% of those employed are working in the IT sector, although some of the others will be in IT roles in other employment sectors (Tuson 2011), in line with the employment pattern of IT professionals nationally (§2.5). The issue of real significance is whether students secure a graduate job in some sector. Professional practice shows that many new computing graduates seek jobs which do not require them to do any programming, clearly limiting their employment options.

The consistently high level of graduate unemployment in computing is partly explained by its gender, age and ethnic profile, with biases which associate with elevated unemployment (CPHC 2012). The loss of graduate-entry jobs is clearly also relevant (§2.5.1). For a range of reasons the Royal Society (2012:27) said during their investigation they had treated this data "*with suspicion*". Outside the industry, blame is often simply attributed to: "*poor quality training courses in*

universities and colleges... Many computer science courses are nothing more than 'sausage factories' (Guardian 2012a:1). Whilst university courses (in any subject) could probably be improved, this particular comment was based on the evidence of the very specific issues raised by NESTA (2011) concerning games degrees (§2.2), although it was not reported as such. Clearly, university courses have a responsibility for the employability of their graduates, but this research will show that the situation is more complex (Chapter 9).

2.4.6 The Coventry situation

Coventry University largely reflects the national picture with regards to recruitment, non-progression, student satisfaction (NSS) and graduate employment. It would be insensitive to present hard data here, although much is on public record, for example in the Key Information Sets (KIS) (HEFCE 2012) on Unistats (2013). For many years these issues have been a source of concern locally. As long ago as 1990 an internal investigation was commissioned to look at departmental issues and particularly at the high failure rate of second year students (Cox 1990). This report identified poor staff morale and de-motivation as being of significant concern. More recently, another investigation was conducted (Broughan 2009) which found that: many students, particularly those on the creative courses (§1.5) or Ethical Hacking, were attracted by specific, specialist course titles; quite a number of students felt unsupported; some felt the course was not as expected; sometimes lecture content is rushed through; sometimes there is inadequate support in laboratory sessions; and students tended to like the practical hands-on and portfolio assessments. Additionally, student relationships and staff motivation were identified as key issues of concern. A particularly telling comment from one academic was:

"we need to get back to being a team, interested in solving problems. We need to start believing in ourselves again. We need to encourage dialogue with critique... We fail to do a lot of interesting/fun things with our students. We need to stop keeping students at a distance. Interact with them, nurture them. We don't foster a relationship with staff – let alone students" (Broughan 2009:12).

At Coventry most computing teaching is done using a combination of formal lectures, laboratory-based practical sessions, supported by practical work, and

perhaps some class-based tutorial question or exercise sessions. Typically this would be undertaken by students individually, although there is a substantial group project in year two. Some students undertake a year's sandwich placement out in industry. The whole degree culminates with a large, individual 'capstone' project. Much of the practical activity is summatively assessed, although there are formative activities too. Students take phase tests and formal examinations. Based both on information in the course KISs (Unistats 2013) and personal discussions, it is clear that this pattern of teaching is reproduced in many university Computing Departments although the balance of learning activities and assessment can vary widely between institutions.

At Coventry over the last few years there has been a move towards Activity-Led Learning (ALL) (Iqbal *et al.* 2008, Payne 2010). Whilst the bulk of the course takes the form just described, for the first 6 weeks of their course students work together in small groups on a broad-based practical computing project. There is very little formal input. Students are required to research and discover what they need to know, based on limited guidance and scaffolding. The aim of this ALL phase is to show students the scope of their degree and motivate them towards learning the material covered in the rest of their course. It also encourages students to take an active, responsible role in their learning and see staff as 'facilitators of learning' rather than 'providers of teaching'. As will be discussed later, students have a range of responses to this segment of their course.

2.5 The IT industry

	IT&T professionals	Other workers
IT&T industry	483,000	430,000
Other industrial sectors	633,000	
Total	1,116,000	

Figure 2-7: The IT and Telecoms workforce

(ONS 2011 data, from e-SkillsUK 2012)

The IT industry is a large and growing one (Figure 2-5 and Figure 2-7) (e-SkillsUK 2012). The term is often used to refer to organisations whose prime business relates to the creation of IT hardware or software or IT service delivery¹⁵. However the IT&T labour market encompasses many roles located within specialist support or development departments, in other industries. For some years now many computing graduates have found it hard to gain employment (§2.4.5) and yet the IT industry reports a skill shortage. Issues surrounding this apparent incongruity will be explored next but also particularly in Chapter 9.

2.5.1 Recruitment gaps and employer requirements

There are widely reported recruitment problems in this growing industry (for example, CPHC 2008b, BCS 2011b) and it is estimated as needing 129,000 new entrants every year (e-SkillsUK 2012). In addition, it is changing, fast.

"Innovations in technology can transform media in months, as is happening now with emerging games platforms such as smartphones, social networks and 3D" (NESTA 2011:5). 14% of organisations reported that some IT vacancies were 'hard to fill': 48% amongst IT&T firms. The most common problem areas were Programmers/Software Developers and Web Design/Development professionals

¹⁵ These figures include the Telecoms industries. There has been a rapid convergence between the IT and Telecoms industries and they have become impossible to separate.

(e-SkillsUK 2012). This is interesting, since these are often graduate-entry jobs, the sort of roles which are perceived as having been lost to the UK through off-shoring (BCS 2011b, Clark and Boyle 2006, CPHC 2008a). There is a similar perception in the US (Mahmoud 2005, Woratschek and Lenox 2009). In the UK, over the period 2001-2011 graduate-entry jobs such as database assistants shrank by 65%; IT User Support Technicians by 11% and IT Operations Technicians by 6% (e-SkillsUK 2012). Conversely, the biggest growth has been in higher-level jobs, such as a 28% growth in ICT Managers. This structural shift is seen as being the reason that many graduates now find it harder to secure their first post: many of the entry-level jobs into the industry have been removed, abroad (eSkillsUK 2012, Royal Society 2012).

E-SkillsUK report that, when investigating the industry's skills gaps, there was *"a wide range of responses... the most common being Microsoft related: .NET/ASP.NET, Dynamics, SharePoint, Visual Basic/Visual Studio and C# together with PHP and VMWare"* (e-SkillsUK 2012:62). Some employers can be very dogmatic in their requirements and may be seeking to recruit staff with previous industrial experience in specific technologies (see §6.5.3).

In a provocative blog, Connor, a headhunter in the City, commented that he was surprised that as few as 17% of that summer's computing graduates were still unemployed. He asserted that many graduates do not have a wide-enough range of technical skills, cannot write English correctly and that academics are under-qualified and *"without exception, [academics']... ignorance of the inner workings of computers is staggering"* (Connor 2010:unpaginated). He rejects many graduates because *"bog standard languages like SQL, VB, Perl, et al. [are] alien to them"* but then asserts, without recognizing his contradiction, that *"a good programmer knows that it is how you think, not the language you code in, that determines your ability"* (Connor 2010:unpaginated). With such an attitude from recruiters, computing graduates are indeed in a difficult position.

This skills gap is not exclusively a UK problem. For instance, it affects the US (Bailey and Stefaniak 2000, Carey 2010, Mahmoud 2005, Woratschek and Lenox 2009), Canada (Cukier 2003), Australia (Orr and von Hellens 2000) and

South Africa (Alexander *et al.* 2011) too. A Computing Technology Industry Association survey¹⁶ in 2012, of 500 US businesses, found that 93% of organisations had some degree of gap in the skills of their IT workforce and 10% considered the gap to be significant (McGlinchey 2012). The perception of potential employment opportunities would be likely to influence young people's interest in pursuing a career in this area. Previous research into this is summarised later (§2.6.2). As will be discussed (Chapter 6), it is graduate unemployment and off-shoring which young people seem to be more aware of rather than the unfilled vacancies.

2.5.2 Gender

If more women could be attracted into the profession they would expand the pool of available talent. However IT has low female participation: a situation that is common in Europe and Anglophone countries (Carter *et al.* 2009, Trauth, Quesenberry and Huang 2006, von Hellens, Trauth and Fisher 2012). At 15% it is lower in the UK than most of the original 15 European Union member countries¹⁷ (e-SkillsUK 2012). Older data, for England only, show the proportion of females in IT&T professional roles is probably still declining, falling steadily from 22% in 2001 to 16% in 2009 (e-SkillsUK 2009a). The position in university computing departments is no better, with only 21% of academic staff in computing or IT disciplines being female¹⁸ (e-SkillsUK 2009b).

With such imbalances many girls may simply not see IT as a comfortable career option. This view is supported by a survey of 500 computer professionals, which provided respondents with a list of fixed options (Computer Weekly 2012a). Over 70% both of males and of females reported that they thought technology was a less attractive career option for women. The most common reasons for this selected by females were because women would not want to be the only female in a team or because they are concerned with the macho image of the profession. Males mostly thought that women were deterred by the geek culture

¹⁶ The resulting report is not publicly available

¹⁷ All bar Germany, Luxembourg, Austria and the Netherlands

¹⁸ HESA 2007 data

or, again, because women would not want to be the only female in a team. This report also highlights that the women who do work in IT are much more likely to be in people-focussed, *"business facing IT and men dominating any hands on technical positions"* (Computer Weekly 2012b:8). This indicates that women shun technical positions to an even greater extent than the headline data suggest. If computing courses and the IT professions are to be able to attract the 'most suitable' talent then supporting women through these barriers must form part of the solution. When considering the appeal of computing to young people this gender imbalance cannot be ignored and, as will be seen, (Chapter 5) it can form a barrier for some girls. Some of the research on women's participation is summarised later (§2.6.2).

2.5.3 Age profile

The IT industry has a reputation for severe ageism, where it becomes much harder to change job over age 30 and very difficult to gain employment at age 40 (Computer Weekly 2000). This was subject to much discussion when anti-age discrimination legislation¹⁹ came into force in 2006. A survey of IT professionals found, *"nearly 50%... said they did not believe it was possible to make progress up the career ladder after the age of 40"* (Computer Weekly 2006). One respondent reported: *"the recruitment consultant didn't put me forward for various positions, and commented: "Aren't you a bit old?" I was 34 at the time"*. However some respondents reported discrimination against the young: *"about 12% of respondents said their search for work had been hindered because they were too young."* (The possible conflation of youth with inexperience will be explored later (§5.3).) Of course, all these reports date from before legislation came into force, which made much practice in this regard illegal. Even if employment practice is now more equal, the image and reputation of a youth-focussed industry lingers. However the reality of employment profiles is somewhat different.

¹⁹ Employment Equality (Age) Regulations 2006

In 2011, the average age of professional workers in the UK IT&T industries was slightly younger, at 39, than the 41 years of workers generally²⁰ and 19% were under 30. However the proportion of young employees has fallen dramatically over the last decade: in 2001 32% were under 30. The industry has an ageing workforce. This is, at least in part, the result of the changing profile of jobs with typical first destination graduate jobs becoming less numerous (§2.5.1) (e-SkillsUK 2012). As will be seen (Chapter 5), the perception of the age of the workforce is part of the image of the profession held by some young people.

Having presented the salient features of the state of computing in the UK the following sections will review the existing relevant research. As has been described (§2.4.1), there is a wide range of degrees within the computing discipline. Although they require different aptitudes and skills sets it seems to be generally assumed that all suffer from the same prejudices and stereotypes (Aken and Michalisin 2007). A US study (Joshi, Schmidt and Kuhn 2003) confirmed that students view Information Systems degrees in the same way as Computer Science ones and assume they are focussed on technical and mathematical skills. The enhanced social and business-facing elements of some courses were not recognised. Thus, in reviewing previous research, it is appropriate to consider studies related to the entire discipline of computing, whilst being aware that this project was focussed on the technical development areas referred to as, say, Computer Science or Computing. Similarly, although this project relates particularly to England, significant research has been conducted elsewhere and hence a wider perspective was adopted. Focus remains on Anglophone countries however since the evidence suggests that there the general attitudes and exposure to computing are similar to, although differing from, those in the UK.

The image of computing as a subject and potential career, held by young people and their advisors, is likely to influence the appeal of computing and whether they choose to apply to study it at university. Having enrolled on their course their experiences and relationship with the subject will affect how they engage

²⁰ ONS Labour Force Survey

with it. Thus the research presented will be that related to the three main themes pursued in the current project: the image of computing, course choice and student engagement, as affects computing students. Generic material on motivation and engagement are covered separately, in the next chapter.

2.6 Research into the Image of Computing

The Royal Society reports that almost all evidence submitted to it asserted that some pupils see the 'image' of Computer Science as being problematic. *"Some students are interested in and excited by Computer Science. For others it is seen as boring, geeky or difficult"* (Royal Society 2012:15). Many authors report that the perceived image of computing (as a subject, course or career) deters potential applicants and that there is a need to re-present it as a dynamic and exciting subject (for example, CPHC (2006) and Computer Weekly (2012b) and in the US, Hewner and Knobelsdorf (2008), Mahmoud 2005, Myers and Beise (2001), Ruslanov and Yolevich (2010) and Woratschek and Lenox (2009)).

First, it is necessary to consider previous research on how pupils view the subject itself: its character. Also, since it must be another factor in computing's attractiveness as a career option, previous work looking at the IT industry needs to be presented, including aspects of research into the low level of female participation in computing. Finally, the character of people employed in IT is discussed.

2.6.1 Pupils' views of the nature of computing

There has been some empirical work in the UK which explores recruitment to computing courses. A number of studies have looked at pupils' knowledge of what they might expect to study on a CS degree or what a career in IT might entail. Studies in Scotland suggest that school pupils in general do not know what CS is (for example, Mitchell 2005, Cutts *et al.* 2007). This is replicated in England (Royal Society 2012). A similar situation is reported by a number of studies in the US (for example, Carter 2006, Hewner 2011, Yardi and Bruckman 2007b), South Africa (Jacobs and Sewry 2009) and Australia (Lang 2012). In a

US study school careers was highlighted as failing to provide adequate and accurate information about IT opportunities (Ruslanov and Yolevich 2010). However pupil ignorance is not neutral. *"Early in their school career pupils form negative opinions of Computing Science, even though many of them admit that they don't actually know what it is"* (Mitchell, Purchase and Hamer 2009:353). There is similar evidence from the US (Adya and Kaiser 2005). Even students who do enrol on a computing course seem to have mis-aligned expectations. *"Anecdotally, many CS staff will comment on how surprised large numbers of their students are about what they are expected to learn"* (Boyle, Carter and Clark 2002:8).

In focus groups with some older secondary school pupils Mitchell found that some were deterred from choosing computing by it seeming 'boring' and 'too difficult' (Mitchell 2005, Mitchell, Purchase and Hamer 2009). Pau *et al.* (2004) reported similar findings, with pupils aged 11-14 identifying IT as being 'boring', 'complicated' and 'not active'.

At a meeting of a wide range of stakeholders, hosted by the BCS and CPHC it was reported that pupils can see computing as being dull and 'uncreative' (Lovegrove and Round 2005). In an investigation for the CPHC (2006), of upper secondary pupils at eight schools or colleges in England and Wales, over 800 pupils completed a questionnaire. Only a slight majority of those pupils taking A-level Computing or ICT agreed that they were enjoying their courses. (Whilst this seems quite poor it is not known how this compares with other subjects.) By contrast, many GCSE ICT students described their course as 'mundane', 'boring', 'pointless' or 'Mickey Mouse'. The most commonly selected reason for not taking A-level Computing was because pupils felt that it is easy-enough to pick up such skills without it, suggesting a misunderstanding of its content. The report asserts that most pupils who were taking an A-level Computing reported that this was because of the 'thrill factor'.

Bell and Corner (2011) identify another issue too though. Since computers have become so ubiquitous and easy-to-use there can be a perception that doing computing is easy. Nigel Shadbolt (the then BCS President) summarised the

situation, echoing the CPHC (2006) findings, that IT and Computing: "*are perceived to be dull, uninspiring and lacking in excitement*" (Shadbolt 2007). He explains that:

"we have succeeded in building an IT infrastructure that is rapidly becoming ubiquitous and pervasive – and as a consequence unremarkable" (Shadbolt 2007:unpaginated).

Technology is now so ubiquitous that, perhaps particularly, young people pay it no heed:

"Facebook, Twitter, iPads, iPhones, Apps, technology is everywhere and yet is not seen as technology" (Inside Careers N.D.).

The situation in the US seems to be similar. In a small study, Yardi and Bruckman (2007a and 2007b) found that pupils see computing: "*as boring, tedious, asocial, lacking in creativity, only for smart students and irrelevant*" and conclude that: "*we need a dramatic change in how computing is perceived*" (Yardi and Bruckman 2007b:2). Unsurprisingly, there seems to be a wide range of reasons why students are not interested in CS (Woratschek and Lenox 2009).

Schulte and Knobelsdorf (2007) analysed a number of student biographies concerning their experiences with computing, looking at differences between those who chose to study computing and others. One significant finding was that students outside computing tend to associate CS both with development work (which Schulte and Knobelsdorf refer to as 'design') but particularly with support work, such as configuration and problem solving work (which they refer to, perhaps unhelpfully, as 'professional use'). By contrast, CS students often see this 'professional use' as being separate from their concerns and activities, although an area in which they usually have skills. This may help explain some of the differing perceptions of CS encountered during investigations. Thus it may be helpful to distinguish computer activity as being of three types: use, design and technical support (or 'professional use').

2.6.2 Research on the perception of IT careers and jobs

Some studies have tried to identify pupils' views of computing jobs and careers. Pau *et al.* (2004) found that their young participants imagined that IT careers

would be similar to their school ICT and just involve the use of applications. Also, some of these pupils do not want a career which keeps them stuck in an office all day. Similarly, Mitchell (2005) found that the nature of IT jobs deterred some pupils. She points to concerns about the ability to secure employment and that other areas of employment were better paid. There are also concerns about not wanting to sit in front of a computer all day. Programming being difficult was also mentioned, suggesting that some pupils equate computing jobs with programming. There appears to be a widespread lack of awareness of the range of opportunities in IT, a situation replicated in the US (Mahmoud 2005, Woratschek and Lenox 2009) and Australia (Lang 2012).

Hewner (2011), in the US, found pupils are often enthusiastic about using computer technology but that this does not translate into believing that CS is a good career to aim for. IT is sometimes perceived to be low status (for example, Lang (2012) in Australia and Lovegrove and Round (2005) in the UK). In the US, Yardi and Bruckman's study (2007a) found that pupils are concerned about a career which would require sitting in front of a computer all day. Woratschek and Lenox (2009) in the US and von Hellens *et al.* (2009) in Germany, all working within the broadest definition of 'computing', report that pupils did not think they would enjoy a technical career like computing, which they saw as being mainly about mathematics and programming, but want a career which involves social interaction.

Germany has a reputation for valuing technical expertise and a study of school pupils there (von Hellens *et al.* 2009) linked computing employment primarily with smart people, being creative and solving problems. However they aspired to a career which was interesting, challenging and involved teamwork but, as in the UK, imagined that computing careers would just be an extension of learning about computer applications, as they had experienced at school (see §2.7).

In the US, Lounsbury *et al.* (2007) highlighted a misalignment of some careers advice. In a sizeable quantitative study, they found that whilst much advice suggests that computing careers suit independent introverts, the IT workers who are most satisfied with their jobs and careers tend to be extroverts who are

predisposed to team work. However the study did not distinguish between the wide range of IT roles, which can have very different demands, and which might influence the benefit of such personality traits. Whilst this study was somewhat weak, it does suggest the potential inappropriateness, and lack of subtlety, of some, though not all, careers advice (for example, Inside Careers (N.D.)).

Computing is often seen as being a male profession (Margolis and Fisher 2002). Women are more common in Information Systems, IT and project management than the development-focussed areas of computing, such as CS, (Computer Weekly 2012, Singh *et al.* 2007) which are the subject of this research. The diminishing female participation has already been discussed (§2.4.2 and §2.5.2) and has been subject to much concern and research over many decades. In the UK significant research into these issues was taking place, certainly by 1988 (Lovegrove and Segal 1991). Lang (2012), working in Australia, comments that the profession is getting increasingly male dominated and that this increasing masculinisation of the workforce may exacerbate matters and women will increasingly be deterred. Whilst gender is not a focus in the current project previous gender research provides some illumination and a brief summary is appropriate.

The gendered perceptions of computing are not worldwide. In some countries there is a balanced gender participation, for example in Turkey (Trauth, Quesenberry and Huang 2008), Mauritius and Taiwan (Singh *et al.* 2007), Qatar (Mahmoud 2005). At the opposite extreme, some ethnic groups identify computing skills as being exclusively male, for example African-American male students in the US (Trauth *et al.* 2012). In a sizeable survey of a group of students of various races, enrolled on computing courses in the US, technical computing skills were considered to be male, interpersonal skills were female and some personality and study skills were considered to not be gendered (Kvasny, Joshi and Trauth 2011). Cukier (2003), in Canada, notes that the IT skills shortage is often presented as relating to the 'male' technical skills although the 'female' communication skills are increasingly in demand. She observes that this will be tending to discriminate against women. Research in the US finds that female Computer Science students can feel alienated by the male culture

(Margolis and Fisher 2002, Singh *et al.* 2007). There have been successful attempts at Carnegie Mellon University to retain more female students by addressing the institutional culture, helping them feel more comfortable and integrated (Frieze 2005, Frieze and Treat 2006), although attempts at replicating this have largely been unsuccessful (Schulte and Knobelsdorf 2007).

Trauth (2002) has considered how the gendering of computing impacts on individuals. The frequently presented view (in Australia at least, but probably elsewhere too) is that responses are a direct consequence of biology: an essentialist view of the issue is presented by much of the media (Ridley and Young 2012). However Trauth notes that people of either gender do not all respond in the same way: their response is not essentialist. Nor is there a deterministic response as a result of society creating IT as a male domain. Rather, in the manner that will be discussed in the next chapter (§3.4), individuals each make their own personal responses to the gendering of the subject, as they perceive it, based in part on their personal gender identity. Trauth calls this the Theory of Individual Difference (Trauth 2002, Trauth, Quesenberry and Morgan 2004, Trauth, Quesenberry and Huang 2006). In addition, any analysis of individuals' responses needs to take account of the cultural position of women in the workplace generally, as experienced within their specific society (Trauth, Quesenberry and Yeo 2005, Trauth, Quesenberry and Huang 2008).

Women's experience of working in IT is the focus of many studies, often endeavouring to understand the processes which led them there (for example, von Hellens, Nielsen and Trauth (2001)). Such studies reveal that women sometimes have uncomfortable experiences. A Computer Weekly survey (2012) found that 65% of women working in IT felt that they had been discriminated against and yet 85% would recommend it as an employment area to other women. Griffiths and Richardson (2010) report some women experience hostility and isolation and can feel that their engagement style is marginalised. Nielson *et al.* (2003) comment that women talk about the computing profession in terms of gendered dualisms (such as technical v. people skills, intuition v. analysis), in a manner which reflects widely held views of IT. Those women may then

articulate their personal experiences as being less polarised (Nielson *et al.* 2003). They may simply accept the *status quo*, get angry or deny the inequity of their experience (von Hellens, Nielsen and Beekhuyzen 2003). As these scholars observe, none of these reactions provide a positive role model for young women. This reputation may not be very supportive of male recruitment either (Computer Weekly 2012).

2.6.3 The stereotype

People working in or studying computing are sometimes associated with a particular sort of image. Mitchell's (2005) work notes that a stereotype of a 'geek' is common, although she does not define that term. 35% of her participants selected this as the main reason people choose not to apply to study computing at university. In the US, Woratschek and Lenox (2009) reported, that most young people do not want to be stuck in an office full of 'geeks', which they identify as implying being asocial, overweight, greasy and male. However in another US study of student views by Ruslanov and Yolevich (2010), only 28% thought you need to be a 'computer nerd' to be successful in CS but over a half thought you need to be 'computer savvy'. Again, the term 'nerd' is not defined. In Australia, Lang (2012) observes that the current stereotype is male, anti-social and hardware focused.

In the US the term 'geek' is seen as insulting, especially for women, though in some countries such as China it is seen as more of a compliment (Trauth, Quesenberry and Huang 2006). The existence of the geek or nerd stereotype in some parts of the world must affect pupils' perceptions and choices. Of course the prime impact will be for it to affect whether students choose to apply, or not (Ash *et al.* 2009, Pau *et al.* 2004, Woratschek and Lenox 2009). However there appear to be other more subtle effects too. Hewner and Knobelsdorf (2008), in the US, note that CS students need to cope somehow with this stereotype of the nerd, since it is usually construed as being negative. They report that the stereotype affects students' identity, with some embracing it and maybe excited by it, whilst others distance themselves from it, even while acknowledging its existence. The fact that CS is difficult can lead some students, especially those

with a high commitment to CS, to work harder and to rise to the challenges. As Hewner and Knobelsdorf report however, some students' commitment is low and such students can feel that they can not cope and might feel excluded. Thus, the stereotype can act as a unifying factor, allowing some students to see themselves as being part of the group and for others to feel excluded.

Sometimes employed light-heartedly, the term 'geek' is used to express deference to expertise, a stereotype which is said to now attract more people than it repels (Bell and Corner 2011), although the evidence is not clear. Nevertheless, this is similar to Hewner and Knobelsdorf (2008) who report that, like other cultural groupings, geeks congregate. This attraction has become known as 'geek chic'. Although Bell and Corner report that people no longer feel the need to apologise for their geeky obsessions, they also observe that the term often attracts people who want to be outsiders, those who are keen to remain different. If CS becomes too conventional then it may become less appealing to some potential applicants.

Thus for some pupils' the image of computing seems to be of something which is dull and lacking in excitement; asocial and office-bound, and male. However, there are pupils who see it as being thrilling and challenging (for example, McGlinchey 2012, Lovegrove and Round 2005). The image of computing, how it is perceived by young people, must be part of how they decide whether or not to apply for a computing degree. Attention now moves to reviewing what is known about the process of how pupils choose to study computing.

2.7 Research into Choosing Computing

The main factors in pupils' choosing of computing, as identified by Lang (2012), were in the areas of: cultural capital (see §3.3), habitus (see §3.3) and self-efficacy. (Self-efficacy, the combination of confidence and competence, is discussed later §3.5.1.) Other studies have explored these and other areas.

Work in Germany notes the importance of early influences on choice-making. *"People's interests, their attitudes towards, and conceptualizations of CS are*

already shaped when students first enter the CS-classroom – whether in school or university – and too often they refuse to enter the CS-classroom at all"

(Schulte and Knobelsdorf 2007:27). Students make their course choice influenced, at least to some extent, by their preconceptions and existing computer-identity.

The diversity of courses in the computing discipline makes it harder for researchers to investigate. But this range also makes it difficult for students to understand what they can expect in a CS course. Thus:

"its breadth... means that there is no established universally-agreed definition that can assist school students in deciding whether they wish to take it or not" (Mitchell, Purchase and Hamer 2009:353).

In 2004, Mitchell conducted a sizeable survey of 2000 pupils, across subjects and age range in Scottish secondary schools (Mitchell 2005, Mitchell, Purchase and Hamer 2009). She conducted interviews and focus groups, in addition to administering a questionnaire. An oft-quoted finding from this study is that the decline in interest in computing is because senior pupils say that they have done ICT in school and they do not see the need to do any more. The most popular reason selected by the older pupils was that the decline in interest was due to the 'geeky' image of the subject. (Of course, since it is not obvious that the image has changed in the last two decades it is questionable whether this really is an explanation of the recent decline.) Mitchell (2005) also reported that 55% of pupils said that their experience of ICT had put them off computing but also that IT is now so commonplace, and largely intuitive, that there is no longer seen to be a reason to study CS. Whilst in the design of her questionnaire Mitchell implied a close connection between ICT and CS, pupils seemed to believe they were related. Several other reports also indicate that pupils tend to conflate ICT and CS (for example, CPHC 2009, Lovegrove and Round 2005, McChesney and Alexander 2006b). This conflation is not confined to the UK. Similar misunderstandings are also identified in Australia (Clayton, Beekhuyzen and Nielson 2012, von Hellens *et al.* 2009) and in the US (for example, Ruslanov and Yolevich 2010).

Carter's (2006) survey of 800 high school pupils in the US identified not wanting to sit at a computer all day as the main reason for not choosing to study CS. Pupils said they just preferred other subjects or wanted a more people-focussed occupation. However 80% of these pupils said that they had no idea what a CS degree would cover. An Australian survey of female school pupils (Courtney, Timms and Anderson 2006) found that they did not see the relevance of computing; they thought it would be too boring or difficult and they sought a more sociable career.

An Australian survey of first-year students of mathematics or computing (Cretchley, McDonald and Fuller 2000) found that the main reasons for choosing their subject were: interest, ability and employment prospects. Whilst these factors are perhaps predictable, they note that for only a slight majority of males (56%) and a minority of females (35%) did interest dominate their choice. For other participants some other factor (perhaps ability, employment prospects or parental influence, or something else) was more significant. This tendency could be important for the students' enjoyment of their course since they suggest that students who have a strong personal interest in their course tend to be more satisfied with it. Students whose main choice factor is their parents' influence tend to become dissatisfied. Girls choosing non-traditional careers seem to be influenced particularly by their parents, and especially their fathers (Trauth 2002, Lang 2012). Relating this to the aforementioned study suggests that there might be a tendency for more girls to become dissatisfied with their course.

McChesney and Alexander (2006a) focussed on finding out why students did enrol, rather than why they did not. They surveyed 900 first year students, enrolled on a diverse range of computing degrees, including ICT and BIT, at a range of British universities. The study was somewhat limited in usefulness in that participants were only allowed to select one item, from a closed list, for each question. They asked: the reasons for their course choice, their expectations and their long-term aspirations. The results were rather bland: many respondents (45%) applied as a result of a 'previous interest in computing'; 45% expected their course to entail working with computer programming; and 55% aspired to secure a 'general computing job' (as opposed to working in some

specialist area). Even for students on computer science-type courses only 53% selected programming as their prime expectation and 22% selected 'general computing study'. It is not possible to guess what those students meant by selecting that category. It is quite likely that no student expected their course to be entirely composed of whichever single aspect they selected. Thus these numbers might be misleading, potentially by a wide margin, although they have been widely cited (for example, Carter and Jenkins 2010). Participants were allowed to add responses to support their choices. Those responses indicated that most participants were unclear about employment opportunities.

In a subsequent study, they questioned 500 new students from four universities, again across a range of computing courses (McChesney and Alexander 2007). Students were presented with an extensive list of computing topics and asked how likely they thought it would be part of their course; how confident they felt that they would be successful in each area; how important certain factors were in their course choice and issues related to their computing interests generally. The analysis is methodologically weak in a number of regards. The main weakness is the very broad range of courses encompassed and yet not separated in the analysis. Students on an ICT degree, for instance, are likely to be very different from those enrolled on Software Engineering. Very many of the subject topics in the questionnaire would have no relevance to any particular participant's degree. Also, the method used to calculate the degree of mismatch of students' expectations and their desires was arithmetically flawed. It is the 'absolute' values of these mismatches which should be considered, not their averages: it is the scale of the individuals' mismatches which matter. The authors also assume that the students' expectations accurately reflect their courses' content. For newly enrolled students, presented with a series of technical topics, it is highly likely that some students do not understand what some of these subjects are nor know if their course includes them. This flawed analysis suggested that students with A-level Computing are more confident than those with A-level ICT. Although such a conclusion is insecure, this is an interesting hypothesis.

Kvasny, Joshi and Trauth (2011), working in the US, found that self-efficacy and career choice seem to be related. They found that students who have high levels of self-efficacy in non-technical areas are less likely to be attracted to IT careers than those with low technical self-efficacy. Those students believed that they could acquire the necessary technical skills when needed. This unfortunate tendency may stem from mis-understanding the nature of IT work, in the manner referred to above as conflating ICT and CS. Trauth (2002) noted the importance of inner strength and self-confidence in girls' successes. Schulte and Knobelsdorf (2007), in Germany, point to self-confidence as influencing female recruitment but also the lack of gender-sensitivity in CS teaching. Koch, Müller and Sieverding (2008), also in Germany, found that women in computing are more reluctant than men to engage if they perceive the possibility of failure. This suggests that self-efficacy may be particularly important in the recruitment of females. Similarly, a literature review (Singh *et al.* 2007) found that women tend to be less confident with computing than men and suggests that it is this, rather than lack of ability, which deters them. Powell (2008), in the US, extends this, arguing that women believe men know more than they do, leading to a loss of confidence and interest in participating. However whilst both male and female IT workers tend to believe that women find technology a less attractive career option and that they would not want to be the only female in a team, women also think that they believe that they would have to work harder than men to succeed, although the men disagreed (Computer Weekly 2012).

Thus there is evidence that many school pupils do not know what a Computing or CS course would involve. They are unaware of the curriculum, not helped by the wide variation in course content. This is problematic for university recruitment, in part because potential students sometimes assume that such courses must be similar to their previous ICT studies. But also, as will be discussed (§3.5), interest in the subject seems to be important for students to be engaged with their course. Self-efficacy and confidence in one's abilities seem to be linked to success and, as just discussed, may be particularly important for female students.

If pupils do choose to apply for and enrol on a computing degree they may enjoy it and persist on it; they may be engaged and they may be successful. As has been described (§2.4.3), this is not always the outcome. A summary of existing research into such matters in computing follows. Generic material on engagement and motivation is presented in the next chapter.

2.8 Research on Retention and Engagement of Computing Students

Analysing retention rates on computing courses across the UK, Livesay, Alexander and Boyle (2003) found that pre-1992 universities have a much higher progression rate. All were over 80% (with average 86%) with post-1992 universities mostly 65-80% (average 74%). At the older universities the 'wrong choice of course' was the most frequently cited reason whilst at new universities it was most often due to academic failure. This is unsurprising in two regards. Firstly older universities tend to have higher entry requirements and therefore overall have more academically able students. In general, such students are less likely to fail (NAO 2007, Boyle, Carter and Clark 2002). Secondly, older universities are more likely to offer a course which is highly theoretical, focussed heavily on the mathematical, logical underpinnings of computing theory (§2.4.1). It may be more likely for some students to react negatively to such an offering than the much more applied, practical courses typically offered by new universities. Similarly, in the US, Ruslanov and Yolevich (2010) observed that student misperception of the content of computing courses leads to poor course retention.

There have been investigations as to what factors are involved in these non-progressions and, most particularly, attempts to identify factors which would predict success, or failure, and which therefore could be used to inform student recruitment. Much early work in this area focussed on students' programming skills since it is the most common cause of failure and student discomfort. Hagan and Markham (2000) compared first-year programming results with students' self-reported prior experience of programming languages.

Unsurprisingly, they found that the students who perform best had prior experience of more programming languages. However, students without any such experience had a wide spread of marks, suggesting that they had a range of aptitudes. The authors comment that in university courses it matters how students construct their programming solutions. For some students with prior experience, if they come from an institution where *"a working program is all that matters, can react negatively [and]... refuse to put in enough effort"*, leading to failure (Hagan and Markham 2000:25). Whilst recognising that the type of programming of which the student had experience could significantly affect the advantage it conferred, they provide insufficient detail for any such effects to be identified.

However other studies have not identified any relationship between programming experience and success. Margolis and Fisher (2002) (in the US) found no relationship between students' self-reported pre-existing skill level and eventual success. Black (2003) also considered this directly, rather than looking at, say, A-level Computing, recognising that this qualification does not always include any programming. This seeming anomaly may explain why studies which look for correlations between success and prior programming may find a connection (for example, Hagan and Markham 2000) but those which look at A-level Computing may not (for example, Boyle, Carter and Clark 2002). Both Black's and Margolis and Fisher's findings did not support Hagan and Markham's link between prior programming experience and success, although the data supporting Black's claims are rather simplistic. For example, basic skills in using MS Word were considered to represent students' general computing skills. (Even a decade ago very many people possessed that level of competence and this would not discriminate adequately.) This is a danger if those with computing expertise are not involved in the survey design. Margolis and Fisher feel it is important that students are aware of this lack of connection, in order to bolster the confidence of those new to programming.

Roddan (2002) investigated the success of Computing Science students. He used Tinto's model of Student Integration (§3.5.1) and looked at factors in students' background and experience which would influence their integration into

university and collected data including student attendance, assignment results, entry point scores, students' background and their socialising habits. He also interviewed a few students to discuss their progress. He found a significant, though weak, correlation between first-year success and students' entry scores (*i.e.* UCAS points). Also, students who are more committed to get a good grade, perform better. However this work could have been subject to some student *post hoc* justification of poor performance since at Glasgow students take three subjects in their first year and after that choose what they wish to specialise in. The interviews suggested that students felt that a natural aptitude for programming (as opposed to experience) may be important.

Student success in two high-ranking pre-1992 universities (Kent and Leeds) was investigated by Boyle, Carter and Clark (2002), who define success as the achievement of at least a 2(i) degree (rather than just not failing). The relationships between first and final year performance and various descriptors of students on entry, such as total A-level points and grades in A-level Computing and Mathematics, were investigated. Like Roddan (2002), they found that students with better A-levels performed better in their first year but not necessarily in their final year. They found no difference in performance between those with or without Mathematics or with or without Computing A-level. It must be noted that these are high-ranking universities and all students admitted are highly capable. These findings may not apply across a wider ability range. The Mathematics finding is particularly interesting since some universities believe a good Mathematics background is both essential – which must be true to some extent for the mathematically-focussed curriculum as offered by some universities (Royal Society 2012) – and a predictor of success.

Somewhat contradictorily, in the US, Katz *et al.* (2006) found that women are more likely to succeed if they have previously studied calculus. The authors assert that this proves the importance of a solid mathematics background and use as additional evidence that the women who have programmed previously do not perform so well. However this is not the only explanation and it seems unlikely since calculus is barely relevant to any computing curriculum. The study failed to take account of the recruitment patterns into mathematics: it attracts the

bright, the logical and those who are comfortable dealing with abstraction. It is these, and not calculus *per se*, which are more likely to be reflected in their ultimate achievement.

Boyle, Carter and Clark (2002) found a relatively weak correlation between first and final year performance, indeed a number of students with relatively weak A-levels (for these high-ranking institutions), around 3 C's, do achieve good degrees. This work was extended by Alexander *et al.* (2003) across seven countries in Western Europe and US, looking for ways to predict student success based on university entry qualifications. However, they also failed to find an effective mechanism. Nothing seemed to predict success in the crucial area of programming. They suggested that it might be more productive to look at per-subject preparation, rather than just the general level of achievement. In both these studies the authors hypothesise that student success may relate to less tangible influences such as students' attitude or learning skills both of which are pertinent in the context of the current research. One study (Sayers, Nicell and Hinds 2010) found a statistically significant correlation between the level of attendance and performance of computing students.

A comparison of Computing A-level curricula and a CS degree first-year (at Leeds University) (Clark and Boyle 2005) concluded that whether A-level helped with degree study would depend on how the A-level was delivered. This is a rather limited conclusion in two regards. Firstly, computing degrees vary widely in content and delivery and will correspond to the various A-level curricula to different extents. Secondly, the experience of having studied the A-level at least gives pupils a sense of what computing is about, even if differs from the nature of their encounter with it at university.

A US study (Katz *et al.* 2006) investigated students' persistence with computing. They considered that students who chose to study a second computing course (*i.e.* module) had persisted with their computing studies. However this fails to address the issue of students' interest. A student may simply have found, through their first course, computing to be of little interest. Curiously, this study found that women (but not men) who had not studied computing pre-university to

be more likely to take a second computing course than those who had prior experience. There are a number of possible explanations. It may reflect a lack of previous opportunity, for some able women, to study computing. Also female students who had studied computing previously may have found the material they later encountered different to their expectations (in the manner of the conflation of ICT and CS, described earlier) or their later experience may have challenged their confidence in their ability. Whilst these US findings cannot be directly transferred to the UK education system, since UK students almost always must choose the subject of their degree pre-application, it is possible that prior exposure has some such sensitising effect on women.

There has been some previous research on the motivation of computing students. A small previous study at Coventry University (Payne 2008) used an Academic Motivation Scale (AMS) measuring instrument (see §3.6.1) to assess the motivation of 47 computing students, 43 of whom were predominantly extrinsically motivated, although they usually also expressed a sizeable, though lower, intrinsic interest in the subject itself. A study in Ireland (Connolly, Murphy and Moore 2006) found that computing students whose prime motivation was extrinsic (as opposed to intrinsic) were less likely to succeed.

Sayers, Nicell and Hinds (2010) observed that computing students have a wide range of motivations, by which they meant reasons for enrolling. Perhaps more interestingly, they noted that only 62% of their students reported having friends at their campus (Magee at University of Ulster) and only 31% on their course. Whilst this is a consequence of 63% of them still living in the parental home, many students sought more opportunities to mix with staff and fellow students to enhance their involvement.

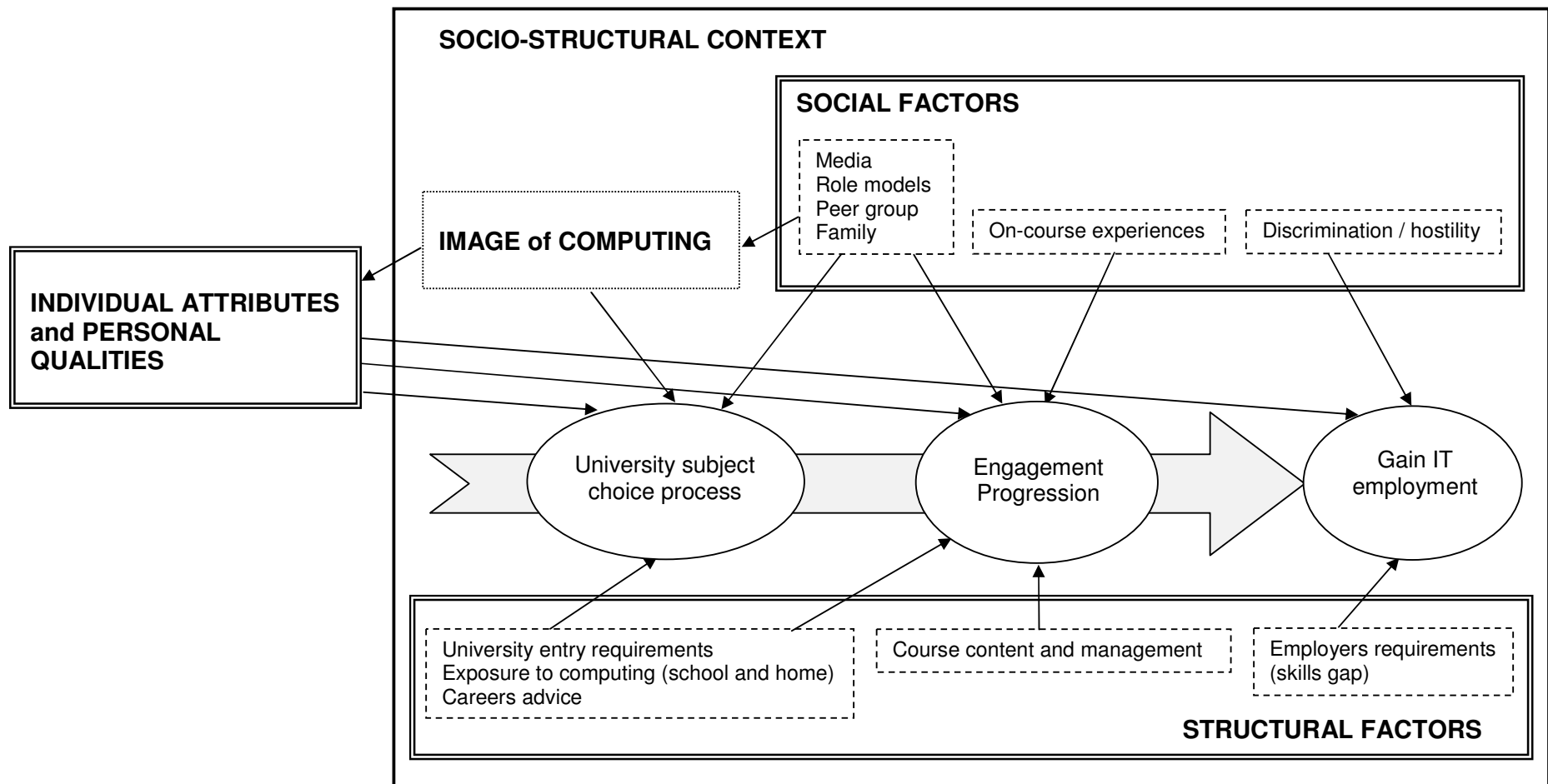


Figure 2-8: The route to computing

2.9 Conclusions

In this chapter some of the relevant issues in the world of computing have been introduced. Technical computing barely exists in many schools: the educational system currently denies most youngsters the opportunity to see what it is about and whether they would enjoy a career in that area. (Policy changes planned in this regard will be discussed in Chapter 9.) The exposure of young people to IT, both in the home and through school ICT, has created a digitally literate generation but one for whom the nature and 'mechanics' of these systems is a total mystery. Implications of this are a reduction in interest in studying computing degrees, although interest may be returning somewhat. The involvement of females in computing is low, and declining, at every level: school, university and IT employment. Coupled with all this, even in a period of high unemployment generally, some employers are finding it hard to recruit suitably skilled staff and yet many new computing graduates find it difficult to secure appropriate employment.

The current state of understanding of these issues through previous research has been summarised. However much of this literature does not directly reflect the prime concerns of the current project: core, technical computing in England. Very little is based in England or the UK, with its unique educational system, although the general concerns about computing do seem to be very similar in other Anglophone countries, particularly in Australia and the US, where much of the work was located. A substantial part of this prior research relates to gender. Whilst gender is not a focus of the current project, and therefore not of direct interest, this literature was the source of some interesting ideas.

The model in Figure 2-8 represents the main influences which seem to affect young people as they move from deciding whether to study computing at university, through to graduation and employment. There are varying levels of confidence in elements in this model. Some elements have a firm foundation and are strongly evident in the literature whilst others are more tentatively suggested. The elements in the model have differing significance too, in that some elements appear to be more influential than others. This research project

was designed to collect empirical evidence which allowed the development of a deeper understanding of some of the processes affecting why pupils might, or might not, decide that they want to study a computing degree. This model should be seen as a framework and sensitising device against which to view new empirical data. Some of the data provided evidence for understandings, which were previously somewhat tentative.

As will be described, three themes emerged which with their evolving research questions, served to focus data collection and analysis. Later chapters will explore these themes. Chapter 5 will look at how the image of computing impacts on young people's desires to get involved then Chapter 6 will consider how pupils make their course choices and Chapter 7 explores how students engage with their computing course. However the next chapter will introduce the main concepts and theories which were used during this investigation.

3 : The Conceptual Framework

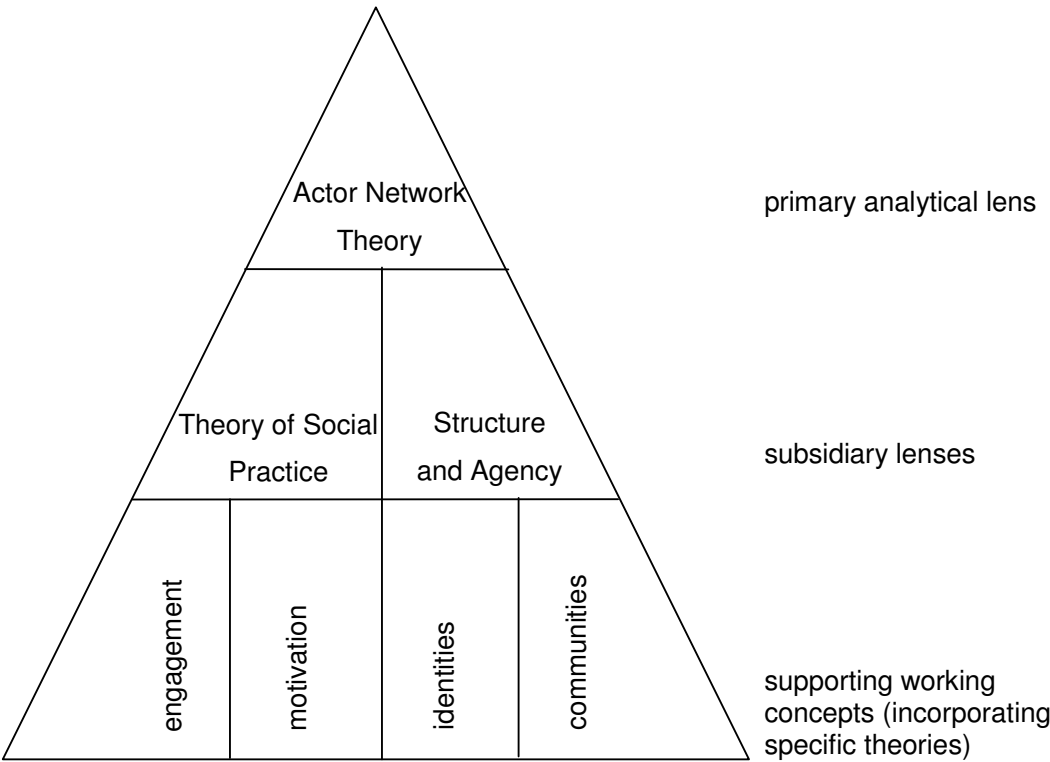


Figure 3-1: The conceptual framework

"If the world is messy we cannot know it by insisting that it is clear" (*Law and Singleton 2005:350*).

3.1 Introduction

Having described the computing background to this project in the previous chapter, the prime purpose of this chapter is to describe the theoretical background and conceptual framework used in this study. The interpretive ontological and epistemological position underlying this research is considered in the next chapter, since this informs the methodology described there. This framework comprises a number of concepts and theories which were adopted to support the analysis of the research data (Figure 3-1). The primary analytical lens was Actor-Network Theory, with subsidiary lenses of the Theory of Social Practice (TSP) and Structure and Agency. Each will be explored, indicating their role in the data analysis.

Having discussed these main theories a small number of supporting, 'working' concepts and theories will be introduced, although more briefly. These are Engagement, Motivation, Identities and Communities and will be drawn on as and when appropriate. Other concepts which were utilised during analysis or interpretation will be explicated when used.

3.1.1 Social theories

The term 'theory' can be used in a multitude of ways and researchers adopting different paradigms and approaches may use the term to "*pick out quite different intellectual phenomena with diverse functions*" (Hammersley 2012:393). A scientific positivist typically uses the term 'theory' to refer to something where the evidence is strong-enough for it to be taken as a proven fact. However in qualitative research, the term is likely to refer to a concept which provides a degree of abstraction, categorising information and, to some extent, generalisation.

Scientific research can employ well-developed statistical techniques to both inform the conduct of research and to prove the validity of its findings. By following the rules of a recognised statistical approach quantitative researchers know that their findings will be reliable and valid. However interpretive qualitative social research is at a much earlier stage of its development. It is not populated by strict sets of rules and constraints. Indeed it is probable that provable, fixed methods, which mirror statistics methods, will never emerge. According to Geertz the search for a general social science theory is undesirable; he considers social scientists to have freed themselves of the goal of developing any such unifying "*social physics*" (Geertz 1983:23). Similarly, Bryman and Burgess (1994b) see such an aim as both undesirable and not possible. Geertz suggests that this raises questions about the aims of social science.

"It is not that we no longer have conventions of interpretations; we have more than ever, built... to accommodate a situation at once fluid, plural, uncentred and... untidy" (Geertz 1983:21).

However, of course, the dismissal of the objective of developing a grand unifying social theory is not to dismiss the objective of theory-generation. The aim of the current work was, of course, to do just that: to investigate issues related to why students' choose computing and to derive new understandings in the form of theorisations.

Social theories vary in their scope and degree of abstraction (Corbin and Strauss 2008, Hammersley 2012, Trowler 2012b). Some theories are broad in their applicability, applying across social contexts. To distance them from the rejected goal of a grand unifying theory these larger-scale theories can be referred to as 'macro' (Archer 1995, Hammersley 2012) or 'middle-range' theories (Corbin and Strauss 2008, Trowler 2012b). The three theories central to the adopted conceptual framework (ANT, TSP and Structure-Agency) can all be considered to be such mid-range theories, being applicable across social contexts and offering fundamental social insights. Some other social theories are smaller in scale or apply in specific contexts and a number of these micro-theories, such as Yorke and Longden's Theory of Student Departure and Wenger's Communities of Practice, were also adopted within the framework.

3.1.2 The use of social theories

The use of social theories and concepts "*offer[s] language for talking about social phenomena*" (Hammersley 2012:397). However it is not just terminology which was provided. The use of established theories provided a means to generate a deepened understanding and explanation of the phenomena in operation in the current research domain. They provided a way of viewing a particular situation or context (Svinicki 2010, Trowler 2012b). Of course the current study also provided some confirmation (or not) of the validity of those theories in the current research domain.

The three main theories each provided a lens through which to view the domain of computing education. Each of these lenses allowed the researcher to focus in on the data corpus, each providing an understanding through focus. Since each lens can divulge its own types of information and views of a problem domain, it is evident that by using a number of lenses it may be possible to uncover more about the domain. Denzin and Lincoln (2005) describe this as the qualitative researcher working as a '*bricoleur*', using a range of methods and theories.

"Qualitative researchers deploy a wide range of interconnected interpretive practices, always hoping to get a better understanding... Each practice makes the world visible in a different way" (ibid.:4).

This idea of adopting multiple viewpoints has been described as a process of "*crystallisation*" (Richardson 2000:934). Each lens exposes a different perspective on the phenomena.

These findings might complement each other, different lenses telling different things. However it is possible that they might contradict and it would be important to explore why this was the case. It might be that different underlying assumptions were being made, for instance. However in considering such a conundrum it is crucial to remember that a lens provides a view of the domain, an interpretation. Interpretations of a domain can differ, without the requirement to determine any to be 'incorrect'. If you look at something from a different viewpoint, you may perceive it differently. In this way, as will be described in the next chapter, the use of existing theories supported the analysis and

interpretation of research data: the conceptual framework provided a means to help the quagmire of the data corpus reveal some of its hidden treasures.

For this to be effective appropriate theories and concepts must be selected. Figure 3-1 represents the conceptual framework adopted in this research. ANT is located at the top of the model since this provided the primary analytical lens, Actor-Network Analysis Diagrams (AADs). These will be described later (§3.2 and §4.5.1) but they permitted an all-encompassing exploration of the influences between elements interacting in a context, both human and non-human, in a manner which can be employed at any scale or scope. The use of these diagrams facilitated the identification of influences between elements in various areas of this project, such as those on a youngster and their university course selection.

The Theory of Social Practice and Structure-Agency were both selected because of their broad social applicability, although they differ in the scales at which they operate. They are represented below ANT in the model since they were subsidiary lenses and the understanding which they generated fed into that derived by using ANT. They helped to elaborate and extend the initial analyses.

TSP considers some aspects of our behaviour and interactions as human beings, looking at personal, individual qualities. This is relevant here since student perceptions are developed through various human behaviours and situations. Structure-Agency considers the ways in which social structures influence individuals' agency, and *vice versa*, providing ways to identify structures and agentic behaviour which affect students' choice. These theoretical lenses were selected as the subsidiary theories for the conceptual framework since they explore the problem domain in ways different to each other and complement the prime analytical device of ANT.

A number of other concepts are shown at the bottom of the model: engagement, motivation, identities and communities. These were also adopted into the framework, as working concepts, which supported the exploration of these social and psychological issues. They were drawn on as necessary during data analysis, extending and deepening understanding. This chapter continues by

exploring each of these concepts and theories in turn, commencing with Actor-Network Theory.

3.2 Actor-Network Theory

ANT emerged in the 1980's from science and technology studies, as a socio-material approach which *"is concerned with the dynamic and simultaneous mutual influence of both the social and the technical"* (Díaz Andrade and Urquhart 2010:353), allowing the investigation of the power which things can exert, affecting relationships.

ANT is generally attributed to Bruno Latour, a sociologist and anthropologist, but was developed with fellow sociologists John Law and Michael Callon, through a process of mutual critique. It has evolved, various elements being used in various ways by authors, changing to such an extent that versions are sometimes referred to as post-ANT or after-ANT (see §3.2.2). ANT has *"translated itself into... many things that are new and different from one another"* (Law 1999:10). ANT was an attractive lens to adopt for this research since it can be applied at any scale (individual, department *etc.*). However it also looks beyond human agency, allowing for the power of objects (Trowler 2012a:701), and thereby has the potential to reveal issues hidden to the previous two lenses.

This section will start by exploring the nature of objects and networks before moving on to explore the symmetry between human and inanimate objects, followed by consideration of post-ANT concepts of fluid and fire objects. The section finishes with a description of how ANT has been used.

3.2.1 ANT – objects and networks

The core principle of ANT is that all entities (or objects) in a context can be seen as being potentially relevant and brought into its analysis: it is an object-oriented approach (Law and Singleton 2005). It is a 'non-modern' philosophy, in that humans and non-humans are treated symmetrically, an approach first used by Callon (1986): that is, social and natural objects are treated in the same way, *i.e.*

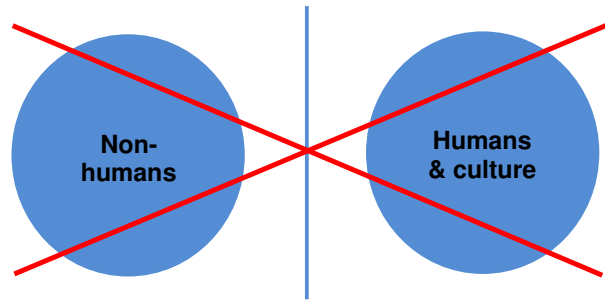


Figure 3-2: ANT does not use purification
(based on Larval Subjects 2009)

symmetrically. In a 'modern' philosophy entities would be categorised, grouped, into sets of like objects through a 'process of purification' (Figure 3-2) but ANT denies such distinctions (Larval Subjects 2009). Most sociological theories, including TSP and Structure-Agency, only consider the human.

In ANT, humans are not seen as being privileged: they just form some of the objects present in the problem domain. Connections between these objects bring them together as a network. These connections are often termed associations (or relations or relationships) and represent any form of interaction or effect between the objects. The objects in a network are often referred to as actors, hence the name 'Actor-Network Theory', coined by Callon (1986).

Amongst its ongoing development there are debates about what ANT really is. At a workshop in 1997, Latour said: "*there are four things that do not work with actor-network theory: the word 'actor', the word 'network', the word 'theory' and the hyphen!*" (Latour 1999:15). Whilst presented in this way, presumably for reasons of levity, he was endeavouring to raise serious concerns about the naming. He wryly opened the workshop saying: "*Thank you for asking someone who never used the word 'actor-network' to speak at the introduction of this meeting [titled 'Actor Network and After']*" (Latour 1998). Latour's view is that, since ANT provides a way of viewing a domain, it would be better considered as a framework and approach, rather than a theory. (As will be seen (§4.5.1), that is how it has been employed in this research.) Latour points out that the actors in the domain do not transmit information without change, as the term 'network' may suggest, but rather that the network itself changes. Latour's concern with

the term 'actor' is that entities do not achieve action on their own, but rather through their associations (Latour 1999). Finally, the hyphen causes Latour concern since it could be seen as making reference to the Structure-Agency duality, which he regards as a cliché (Latour 1999).

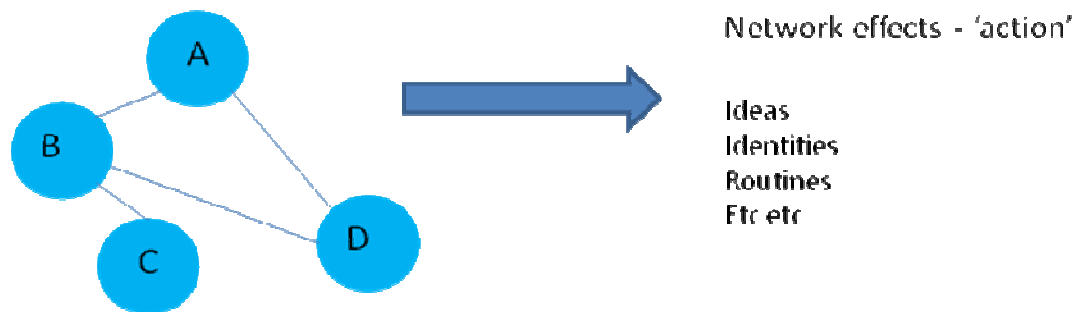


Figure 3-3: Network effects

At the heart of ANT is the facility to view a collection of objects, which have 'associations' with one another, as a network. These individual objects are considered to be 'actors'. However the whole network is also an actor: both objects and networks can enact effects - they can contribute to actions. The interaction of objects in networks could be presented graphically (Figure 3-3).

However ANT is not associated with any significant form of diagrammatic modelling although Callon (1986) employed some simple schematics. There seems to have been no significant usage of diagrams for modelling which seems curious for a framework which, in its very naming, calls on a visual metaphor. Latour himself noted that there was an urgent need for the derivation of an improved "*digital datascape*" for the presentation of social data (Latour 2010). By this he meant that there needed to be ways of using digital technologies to present social data for dissemination and interrogation. Whilst not suggesting that the current work would assist with Latour's project, a form of ANT diagramming has been developed within this research, which proved useful for analysis (§4.5.1).

ANT is generally regarded as a flat ontology, meaning all objects are on an "*equal footing*" (Larval Subjects 2009:unpaginated), although of course some do

have a greater impact. However many actors can themselves also be considered to be a network and decomposed into a number of interacting 'sub-actors'. Thus whilst networks are actors, actors are also often networks (Latour 2010, Fenwick and Edwards 2010): "*actor and network... designate two faces of the same phenomenon*" (Latour 1999:19). In this way objects and their interactions can often be seen to be nested or hierarchical, with some objects encompassing networks of others.

However ANT is not quite as simple and symmetrical as has been suggested. Not all entities (*i.e.* objects) are actors: that is entities do not always 'act', or have an effect. In other words some entities are intermediaries, and not mediators of action themselves (Fenwick and Edwards 2010). Some early ANT work tried to make this distinction, by using the term 'actor' for entities which exhibit agency and 'actant' for supporting entities (Fenwick and Edwards 2010). This terminology will not be adopted here.

Object symmetry caused difficulty with the acceptance of ANT, most particularly the view that human entities must not be privileged. Additionally, the adoption of the term 'agency' in the context of inanimate entities led to critique based on the intentionality of human action (Fenwick and Edwards 2010). Latour clarified his position:

"ANT is not, I repeat is not, the establishment of some absurd: "symmetry between humans and non-humans". To be symmetric, for us, simply means not to impose a priori spurious asymmetry among human intentional action and a material world of causal relations" (Latour 2005:76).

An early use of ANT was in the seminal study by Callon (1986) investigating an attempt to reintroduce scallops, the coquille Saint-Jacques (*Pecten maximus*), into St Brieuc Bay in Brittany (Figure 3-4). Callon analysed the records of how the aquaculture researchers investigating the scallops, along with other interested but non-specialist scientists, had worked with the local fishermen in this endeavour.



Figure 3-4: Coquilles Saint-Jacques

(source:<http://luirig.altervista.org/biology/main.php?taxon=Pecten+maximus>)

Callon identified four 'moments of translation' which many networks will go through as they develop. Whilst Callon's study has been highly influential, few ANT studies seek to identify these stages and this project does not either. The stable end-state which some networks eventually achieve is termed 'immutable mobile'. An immutable mobile is an object, or network, which does not change – it is immutable – although it can move in location or extent. Some networks achieve this character and are stable; others are dynamic, constantly changing and may even die.

3.2.2 Post-ANT – fluids and fires

By the early 1990's there was a recognition that not all object networks behaved quite as tidily as the earlier ANT work had suggested. The very nature of an 'immutable mobile' object – "*something which moves around but holds its shape*" (Law and Singleton 2005:335) – was challenged. It was recognised that some objects gradually change and are 'fluid' in nature. Despite having permanence, they are mutable. "*Oxymoronically, [a fluid object] is something that both changes and stays the same*" (Law and Singleton 2005:338). Their example is of water pumps in Zimbabwe which were all the same when installed, but each was subject to unique improvised repairs, based on the materials available

locally. Thus, the pumps' designs slowly diverged and therefore they can be viewed as fluid and mutable.

'Fire' objects have a randomness and unpredictability, such as is exhibited by an uncontrolled bush-fire. Different instantiations of an object may have different qualities present and absent, so called 'absent presences': "*absence, otherness, is integral to objects*" (Law and Singleton 2005:349). This leads to differences between objects which can appear as discontinuities. The absence of fuel will extinguish or prevent fire but the presence of fuel does not guarantee fire, that depends on the introduction of a source of intense heat.

Law and Singleton (2005) found that patients being treated for alcoholic liver disease at hospital, clinic and GP's surgeries had very different experiences. Their investigations showed that this was due to differences in the stage and severity of the patient's illness but also in the treatment objectives in that context. Qualities present in some contexts were absent in others. Alcoholic liver disease can be considered to be a fire object, which was perceived as having a very different form in each of these situations. The apparently random and unpredictable situations which can be found in the 'real world' context of a study must be amenable to investigation. Absent presences, fire objects, allow this. "*If the world is messy we cannot know it by insisting that it is clear*" (Law and Singleton 2005:350).

This ontology highlights that actors differ in their behaviour, weakening the uniformity which could be inferred from the original 'actor-network theory' title (§3.2.1). ANT has developed so much that some authors have referred to this entire collection of concepts as 'after-ANT' (Fenwick and Edwards 2010, Law 1999), or 'post-ANT' (Law and Singleton 2005). Whilst it is odd to refer to something by that which it is not, this does retain the coherence of the developing concepts.

3.2.3 How it has been used

ANT provides a way of thinking and viewing a problem domain. By requiring the symmetry of importance of actors it encourages, nay demands, that attention be

paid to the influences of non-human entities. The recognition that individual instantiations of an object can exhibit different qualities and properties in different contexts, as an absent presence, fire object, allows the messiness of the real world to be explored. It allows individual cases to be investigated and then the meaning behind both the objects' differences and commonalities to be examined.

ANT can be used at different scales or granularities: the single student, the cohort, the phenomenon, giving it flexibility. Different networks could be derived, maybe representing development over time. These can identify common patterns or highlight differences. It is this usage which proved most valuable, allowing the relationships between various influences on student choices to be examined. However, all ANT provides is a way of thinking about a problem domain. It grants a way of investigating messy situations, in particular any which involve both human and inanimate objects. Most particularly the diagramming method, AADs, developed based on these aspects of ANT, as described later (§4.5.1), provided a useful way of analysing research data by focussing in on the interaction of objects and supporting the understanding of those relationships.

Like Actor-Network Theory the subsidiary analytical theories are also based on constructivism. However, unlike ANT, both TSP and Structure-Agency are "cultural theories" (Trowler 2012a:697) which look at the relationships between human behaviour and social structures. The use of these theories as subsidiary lenses in the analysis elaborated the initial understandings created using ANT.

3.3 Theory of Social Practice

Pierre Bourdieu's work on social practice and social reproduction has been profoundly influential in the social sciences. The concept of social reproduction may not initially seem to be particularly relevant to computing education.

However Bourdieu considers that:

"the way in which we produce our actions is already shaped to fit with and reproduce the social structures because this is what enables us to act effectively" (Calhoun 2000:709).

Thus actions lead to the perpetuation of social inequalities and, whilst these are not of direct concern here, the processes and issues which can either result from them or lead to them, certainly are.

"Every institutional educational system owes the specific characteristics of its structure and functioning to the fact that... it has to produce and reproduce the institutional conditions... [for] self-reproduction of the system" (Bourdieu and Passeron 1977:54).

Thus Bourdieu asserts that education 'keeps everyone in their place': the antithesis of the overt, current discourse of social mobility. Bourdieu's Theory of Social Practice embraces the three inter-related concepts of field, habitus and capital.

3.3.1 Field

Bourdieu used the term field to mean a particular social context. *"A field... defines itself by... defining specific stakes and interests, which are irreducible to the stakes and interests specific to other fields"* (Bourdieu 1993:72). It could be, say, religion, education or a profession, such as IT (Clark and Zukas 2012). An individual human agent lives in, and moves between, many fields. Each field has rules which, along with the agent's habitus (§3.3.2) and their capital (§3.3.3), affects the agent's behaviours in that field. Thus a field can be seen simply as one area of a human agent's life.

3.3.2 Habitus

Bourdieu's concept of habitus is the collection of perceptions, values and norms adopted by an individual (Calhoun 2000). Habitus is one's core beliefs and 'way of being'. It is the way one views and interacts with the world; one's learned dispositions, behaviours and habits (Calhoun 2000). *"Habitus... is the basis from which lifestyles are generated"* (Bourdieu 1993:127). An individual's habitus thus affects how they perceive a situation and how they might react to it. It affects the *"structuring of all subsequent experiences"* (Clark and Zukas 2012:unpaginated) and is part of who they are. Habitus affects one's belief in education and work ethic (Lang 2012). As an individual grows up, during their socialisation, they tend to develop a habitus based on that of the people around them, most

particularly that of their parents. Thus attitudes and habitus tend to get reproduced through the generations in a family (Bourdieu and Passeron 1977). This will be important in considering pupils' aspirations to attend university.

People in different social classes tend to have different types of habitus (Bourdieu 1993). The Bourdieusian view is that the education system only acknowledges the habitus of the most powerful classes. By working-class knowledge and skills not being valued in the same way as that of the middle-class Bourdieu asserts that there is a systematic bias against the working-class in education (Macionis and Plummer 2012). For instance this can lead to an additional tension in the transition to university for working-class students where the difficulty of coping with an unfamiliar environment can be exacerbated by unfamiliar norms and expectations.

"Students who are unfamiliar with these [elite cultural] codes find it difficult to achieve educational success... because the transition from home to university is harder for them to complete" (Yorke and Longden 2004:80).

Whilst this is likely to be the case in large, locally recruiting metropolitan universities it is probably more extremely felt in ancient, highly selective ones. The fear of such a dissonance could deter potential applicants but habitus will also affect how they respond to opportunities more generally and may influence how they engage with their course.

The concept of habitus is central to Bourdieu's argument that people are social agents who develop strategies to live in the world around them, and habitus influences their behaviour through their views and attitudes. However, as will be discussed later, with the theories of structure and agency (§3.4), there are tensions and debates as to the degree of control which structures impose on agents. Bourdieu does not really address this balance but views much social life as being almost deterministically controlled with little capacity for human agency. He sees social science as being about *"progress in the knowledge of laws of the social world"* (Bourdieu 1993:25). For him fixed laws provide 'social reasons' for things being as they are, which implies that fixed social constructs constrain and control human behaviour. However Bourdieu does also acknowledge that these social laws are unlike the laws of physics, in that they do at some point cease to

operate. Nonetheless the use of terms such as 'laws' (albeit through translation) does imply diminished agency and little scope for individual freedoms.

3.3.3 Forms of capital

The last concept in Bourdieu's social practice theory is that of capital. The idea of capital dates back to Marx (Calhoun 2000) but Bourdieu worked on classifying and examining various types of capital (for example, Bourdieu 1986). Economic capital – personal wealth and income – had long been recognised as a powerful social force (Macionis and Plummer 2012). Bourdieu commented:

"As regards economic capital, I leave that to others; it's not my area. What concerns me is what is abandoned by others... cultural capital and social capital" (Bourdieu 1993:32).

Bourdieu (1986) however actually identified three other forms of capital, which interrelate, and help the understanding of human interactions: social, cultural and symbolic. Social capital comprises the individual's connections to others, helping the individual to use and exploit, to mobilise, their other forms of capital, discussed later (§3.3.4). An individual's cultural capital is their education, intellect and demeanour, as well as their cultural knowledge. Symbolic capital seems to be the Bourdieusian capital least used by subsequent researchers. It comprises the status and recognition given to an individual by their community. Bourdieu used these interlocking forms of capital to explore how people interact and relate in social life.

Contemporary scholars have expanded Bourdieu's idea of capital to describe other qualities of individuals. For example, human capital consists of an individual's skills, knowledge and abilities: the things of which they are capable and physical capital is the collection of the physical resources available to them (Bassani 2007). These forms of capital are usually considered at the individual person unit of analysis but are sometimes applied collectively to entire groupings, such as a family or community (Bassani 2007). The nature of various capitals available to a young person, and their family, will be shown to affect their opportunities to consider applying for a computing course. However social and cultural capital appear to be pivotal.

3.3.4 Social capital, potential capital and its mobilisation

Of all forms of capital it is the social capital which has been most developed within social science. Bourdieu defined social capital as:

"the aggregate of the actual or potential resources which are linked to... membership in a group" (Bourdieu 1986:51).

It is the social capital associated with a healthy pupil-teacher relationship which allows a youngster to fully benefit from the opportunities available in the classroom. A child only fully benefits from the human, social, cultural and physical capitals of their parents if they have a healthy dialogue (Bassani 2007).

Bassani (2007) carefully distinguishes the existence of a resource as potential capital and the presence of mobilised capital: resources may exist yet not be mobilised into capital. For example, reserves may be locked away unseen in an account and, whilst they may be earning interest, instead they could be mobilised and maybe invested in some activity where they might have a greater impact. Bassani asserts that social capital is the engine which drives the mobilisation of diverse resources into various forms of capital: human, financial, cultural and physical.

Young people are almost always subject to three major influences, family, peers and school, as well as typically many less significant situations. The effects of capital operate in all social situations: a young person's capital will, of course, tend to develop as a consequence of their presence in each of these contexts. Bassani (2007) hypothesises that weaknesses in capital in one context can be compensated for by strength in another. Weak cultural resources and capital in, say, the home may be compensated for by the cultural awareness and activities developed through, say, school. Similarly she suggests that the weak human capital in one context, such as attending a disadvantaged school, can be compensated for in another, such as the home, through the experiences provided by dedicated parents. She also suggests that whilst compensation between contexts can happen, for some young people weak capital in one context may be experienced alongside weak capital in others, giving a 'double jeopardy' effect. Likewise some fortunate young people may benefit from the

'boosting effect' of experiencing high levels of mobilised capital in multiple social situations.

3.3.5 The formation of social capital

Bassani asserts that there are three features which influence the level of social capital development: bridging, values and closure. Bridging is when someone belongs to more than one social grouping. The individual develops social capital from each group separately but the groups each also develop their capital. The amount of capital developed depends on the strength of those connections (Bassani 2007). The university experience can be a very powerful bridging one, straddling between home and university, leading to significant development of social, and well as cultural, capital.

Values also affect the development of social capital. If very different values are adopted by the various groups which a young person joins, it can weaken their development, by causing confusion to the developing personality. This is counter to findings from research with adults where those who are exposed to a range of different values, can develop social capital, as an enhanced awareness (Bassani 2007).

Finally, Bassani (2007) reports that groups which are self-contained can lead to a strong sense of belonging and enhanced social capital, although if the group is too tightly closed, without opportunities for external interactions, it can stultify the individual. In the context of students, this suggests that a strong course identity should support their development.

3.3.6 The use of the theory of social practice

Bourdieu's objective in looking at social reproduction was to discern why social inequalities continued to persist (§3.3) and to understand the interplay between external social structures and the experiences of the individual. He used the concepts of habitus and fields to understand human agents' behaviour and reactions. However an important element in this interaction is the range of capitals which the agent brings. Bourdieu presents his framework as being constraining of human agency, which would seem to be the case. However,

whilst the balance of power between social structures and agency is discussed next, Bourdieu's ideas have been profoundly influential and applied to many social spheres. Social capital and habitus, in particular, have come to form core tenets in much sociology research.

In this research these concepts are frequently called on during analysis. As will be seen in later chapters, social and cultural capital was particularly useful in exploring how students come to be aware of the nature of computing and their process of course choice (Chapter 6), the peer pressure issues associated with student engagement (Chapter 7) and the image of the geek (Chapter 5). Habitus was also useful in considering course choice (Chapter 6) and also whether or how students engage with their course (Chapter 7). Bridging, values and closure were useful when looking at the way students view computing and therefore informed all three analysis themes (Chapters 5-7).

Closely related to some of these TSP concepts are the ideas of Structure and Agency. These too have been widely adopted by social researchers and will be discussed next.

3.4 Structure and Agency

Structure and Agency matter for the current work since they allow a focus on the social constructs experienced by young people and their responses and actions with regards to educational choices and their perceptions of the subject of computing. The influence of social structures was detected throughout this project.

3.4.1 Agency

Human beings are not automata, pre-programmed to behave in particular ways: we do not live in a deterministic universe. But rather humans have choices as to how they conduct their lives: they have volition and, to some degree, free will. Giddens (1993) refers to individual segments of behaviour as 'acts' and collectively they comprise 'agency', which is the "*lived-through process of*

everyday conduct" (Giddens 1993:81). Thus humans are agents, have agency and exercise choice as they go about their lives. Bandura, taking a more psychological perspective, says: "*to be an agent is to influence intentionally one's functioning and life circumstances*" (Bandura 2006:164). For Bandura the emphasis is on the actor's intention as well as their action.

Bandura (2006) notes that human agency can be considered at a range of levels of scale: atomic, molecular, biological, psychological and social structural, each having its own properties and laws and that none alone can fully account for human behaviour. However whilst Bandura is considering human behaviour, looking at motivation and agency from a psychological perspective as operating within social structures, it seems that Giddens is more concerned with a higher level, of how social structure and human behaviour are linked. They have similar views as to the nature of agency but appear to encompass different, complementary issues in their consideration of structure.

3.4.2 Structure

Structure in society refers to the rules, norms and so forth which exist in a social context. They are the recurrent and habitual patterns in social life. Structures are particular in their detail to specific contexts: some elements are overt but others are very much less obvious and may be covert. For example, a student would probably be aware of a university rule that coursework must be submitted on or before the specified deadline. However there may be an unwritten local norm that, if you ask lecturer X they will accept late work the next day. Such a norm may be explicitly communicated to students or may be left as a covert understanding. At Harvard Business School socialising is considered to be very important and there is an expectation that all students go out every night. If they fail to do so then they will be challenged by their classmates: "*Where were you last night?*" (Cain 2012). This expectation is a cultural norm produced, and reproduced, by peer pressure.

Humans operate within 'societal rule structures' but individual people react differently in their adoption, enforcement, circumvention or opposition to their particular local rules and expectations: there is a diversity of responses (Bandura

2006). People have choices. Whilst agreeing that of course individuals react differently, is neither to deny that conventions and pressures of social structures exist nor to suggest that individuals' responses to them are entirely unpredictable.

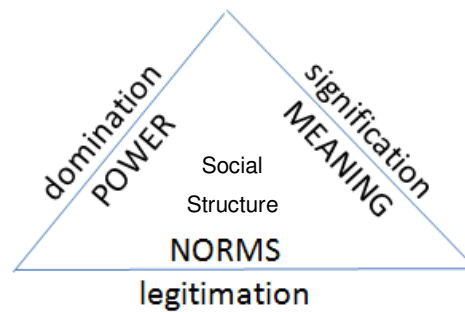


Figure 3-5: Giddens' elements of social structures
(derived from Giddens 1993)

However the structures in social life are more than sets of rules, norms and expectations. Giddens (1993) describes interactions as having three elements which together create the social structures (Figure 3-5). All social interaction is an attempt to communicate meaning. The interaction may include a verbal element or it may be some communicating gesture or movement: the sender is intending to convey a semantic meaning through the interaction. Examples range from verbal dialogue; to a cyclist's hand signal; to a raised eyebrow which expresses a query; to the grunt of agreement between long-term partners. However these interactions are only effective, in that the intended meaning is only conveyed, if the sender and the receivers are all using the same interpretive scheme. A common interpretive scheme permits agents to understand what each other is saying and doing; the mutual knowledge allows the significance of individual interactions to be interpreted. Thus interpretative schemes permit a communication of meaning which gives signification to interactions in social structures.

Interactions also involve the adoption of local norms and expectations. Sometimes a context may 'require' an agent to behave in a certain way, as a result of a moral obligation or expectation, and they may, but need not, comply. Students may be expected to be in class at 9am. Most will probably comply but there is nothing within that expectation to physically force the reluctant student out of bed. However, there are also rights which are exercised through the operation of norms. Students have the right for a lecturer to turn up and deliver their class. Norms (and staff employment contracts) mean that classes almost always do get delivered: the norm leads to an obligation on the lecturer which fulfils the students' rights. Norms provide a legitimation of interactions within social structures.

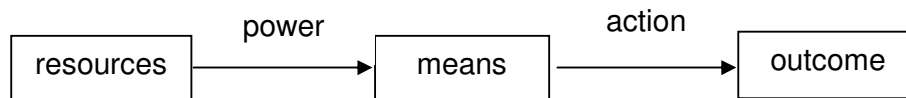


Figure 3-6: Giddens' power and action relationships

(derived from Giddens 1993)

The last element in social structure is that of power. Power is used in interactions by employing facilities and resources to generate desired outcomes through influencing the conduct of others. However as Giddens (1993) notes, power and action are related (Figure 3-6). Action is the application of means to achieve outcomes. Power is the capacity to mobilise resources to provide those means. The operation of power in an interaction is the use of facilities or resources to dominate, producing desired outcomes.

When considering the operation of any social structure, understanding can be enhanced by considering these three elements. They provide explanatory power and help in gaining insights. The balance between them varies between contexts and often one is most useful.

3.4.3 Which prevails: structure or agency?

Whilst the importance of social structures and agency have long been recognised, in the past there has been a debate as to where power lay:

"*individual versus society*" (Archer 1995:6), which was latterly expressed as the " *'structure and agency' problem*" (Archer 1995:6). The debate lay in whether the individual agent is in control and deterministically creates social systems, through a series of disconnected individual acts. The alternative was whether society controls and constrains individuals' actions through its structures. In other words the debate was whether agency or structure alone deterministically causes social action. It seems evident that neither reflects modern Western life, in general. This is not to say that there may not be isolated examples where people live very constrained, prescribed existences nor some unstructured situations where individuals live in whatever way they wish. But neither of these extremes is how society operates generally. Society is not governed by fixed deterministic laws because humans use their freedoms in deciding how to behave (Archer 1995).

Instead structure and agency are related in some way, rather than social lives being entirely caused by either. Archer describes this as that they should not be conflated but rather that they have "*independent properties, capable of exerting autonomous influences*" (Archer 1995:6) and both need to be considered. She asserts that there are now two ontologies competing to provide an explanation of how structure and agency interact: 'structuration' and 'social realism'.

3.4.4 Duality of structure: structuration

Structure and agency operate together, interacting with one another. Giddens (1993) describes this as a process which he termed 'structuration' in which structure and agency are inextricably linked. They form a single duality, operating together 'as one', to produce social actions. Structures affect agents and agents influence structures. In structuration, structure is both made by human agency but it is also the medium of its constitution. "*Structures only exist as the reproduced conduct of situated actors with definite intentions and interests*" (Giddens 1993:134). In other words, not only do agents make the structure within a social context, but that structure exists only in and through its affect on the behaviour of those agents. Agents cannot act without drawing on structure and that, in turn, relies upon the action of agents for its existence.

Thus, in structuration, structure and agency are seen as having an interactive and reciprocal relationship. In this duality, social structures are seen to constrain an agent's actions but they are also seen as supporting and enabling its agency. Thus local norms and unwritten rules restrict some behaviours but can facilitate others. However the individual has choice in their actions and whilst they may be influenced, they are not fixed and determined.

From the psychological perspective of social cognitive theory, Bandura describes a slight variant of these interconnections as: "*human functioning is a product of a reciprocal interplay of intrapersonal, behavioral [sic], and environmental determinants... Social cognitive theory rejects a duality of human agency and a disembodied social structure*" (Bandura 2006:165). Through his rejection of a duality, Bandura may be read as contradicting Giddens' stance, but the point Bandura is making is at a different level of consideration. He accepts that structure and agency interact but seems to be emphasising three points. Firstly, social structures are not disembodied but rather the structures are populated: humans create and exist within those structures. This is Giddens' duality. Secondly, the connection between structure and agency is not deterministic but rather that people have a choice in their behaviour. Giddens does not suggest otherwise. Thirdly, Bandura also brings into explicit consideration interpersonal and contextual factors, seeing these as affecting human functioning. Giddens views such matters as being part of social structure. Giddens sees human interactions as being at the centre of social structure, with facets of power, norms and meaning. These in part comprise, but also reflect, the intrapersonal, behavioural, and environmental factors which are of greater concern to Bandura, as a psychologist. This apparent difference of view between Giddens and Bandura seems to be more of a difference in emphasis.

The structure of a social situation is produced by and through the agency of individuals: they exert power on each other. However the interplay between structure and agency is much more widespread than just in the operation of power. Considering the other elements of social structure identified by Giddens (§3.4.2), alongside Bourdieu's work on reproduction (§3.3), it is clear that the actions of humans have also created the interpretive schemes of meaning and

the social norms. Also, not only are these features of structure the creation of agents (the production of structure) but human agents also cause their continuation – their perpetuation (the reproduction of structure).

Whilst agents cause structure to reproduce itself, that structure does slowly, gradually change. It is by the exercise of power that domination and authority are maintained but the nature and degree of that power is not static and will gradually evolve over time. School teachers used to be highly respected professionals who were conferred with great authority. In recent decades they have seen their status diminish and are now frequently challenged in their professional decisions by some parents (MacBeath and Galton 2008). The interpretive scheme used to unpick the semantics of an interaction also gradually evolves, most noticeably through the evolution of language.

Norms and moral acceptability likewise evolve. The behaviour of some can lead to a norm changing so that such behaviour, instead of being seen as aberrant is seen as acceptable. Just 20 years ago a student who was late for class would either choose not to enter or would be uncomfortable and apologetic at walking in late. However the norm has changed and nowadays it is widely considered to be acceptable to arrive late. Thus both the production and reproduction of social structures can be seen to be the result of the interplay of structure and of agency.

Archer (2013) observed that whilst reproduction of social structures was largely the case in previous generations, in recent times the pace of change has been profound. The life-experiences of successive generations are very different from one another. Young people cannot expect to model themselves on their parents' experience. The *modus vivendi* of previous generations cannot always be replicated. Archer sees aspects of society as being transformed rather than reproduced. In some regards at least this does seem to be the case. Many areas of traditional employment no longer exist and dispersed families mean traditional domestic and family support structures often no longer exist. Young people may need to create these for themselves. Similarly youngsters can be more expert than their parents, particularly in technical areas. Indeed some

parents may have little understanding of their nature let alone be able to give their offspring any advice or guidance. This is not the reproduction of social structures. When considering a dynamic area such as computing education, this must be a significant matter. If Giddens's structuration theory were founded on the reproduction of social structures then this tendency towards transformation would bring it into question as a model of modern society. However it is not evident that social reproduction is an essential element of structuration, even though it is one part of its articulation.

3.4.5 Archerian social realism

The second active ontology is that from the perspective of social realism. Archer (1995) considers the duality of structuration to be a form of conflation which, like the earlier conflations (§3.4.3), should also be disregarded as inadequate. Although structure and agency interact, they have separate properties and therefore they need to be considered separately, as a dualism, rather than a tightly inter-linked duality. Archer (2013) sees this as increasing the explanatory power of structure and agency.

Archer (1995) sees the task of social theory being to link the social and systemic aspects of society and how people interact with elements of society. As well as looking at how structural properties impinge on agents it is also important to consider how the agents use their personal powers to respond to those structures (Archer 2013). It is evidently correct that in very many circumstances agents have choices in their responses and consideration of these is important to the understanding of social events. However those responses may not be rational since people bring their own subjectivities, understandings, priorities and goals into their choices (Archer 2013). Archer thus concludes that: "*courses of action are produced through the reflexive deliberations of agents who subjectively determine their projects in relation to their objective circumstances*" (Archer 2013). This emphasises some aspects which are not evident in structuration, in particular the individuality of circumstance of agents and their human fallibility. These must influence action.

Structure and agency are important concepts in the current study. They will be used to endeavour to gain an understanding of the image of the subject (Chapter 5), influences on computing students' choices (Chapter 6) and behaviours (Chapter 7). This summary of Structure-Agency completes the description of the main and subsidiary analytical devices. There now follows a description of the various supporting, working concepts also employed: engagement, motivation, identities and then communities.

3.5 Engagement

Engagement, as specifically related to computing students, was discussed in the previous chapter (§2.8). This section will now address student engagement as a generic concept and concern. Student engagement is a concept around which many theories have been developed. However it has been used to mean very many different things (Trowler and Trowler 2010, Bryson 2010). In part, this diversity reflects the differing objectives and contexts of its usage. The QAA commented that:

"the concept of student engagement... has evolved over time and has been applied to any of the following: time spent on task; quality of effort; student involvement; social and academic integration; good practices in education; and learning outcomes" (QAA 2012: 2).

What are of concern here are issues relating to the students' involvement, and active participation, in their course itself, in its teaching and learning activities and most obviously whether they are present in, or absent from, classes.

Engagement in this sense is one of the themes which emerged in this research. Dean and Jolly deepen the understanding of engagement by noting that it also involves an emotional connection and risk:

"Student engagement [is when]... not only students' time and physical energy [is] directed toward learning opportunities, but also the emotional energy required to enter into the adaptive learning process. Engagement occurs when students accept a level of identity-based risk and are willing to experience potentially emotional outcomes associated with learning, both positive and negative" (Dean and Jolly 2012:235).

It must be noted that engagement and disengagement cannot be seen as binary alternatives: engagement is more appropriately seen as a spectrum. Student dis-engagement, or the absence of, or very weak engagement, is seen as being a factor often associated with student withdrawal or failure, and understanding it is seen as a route to improving student performance (Trowler and Trowler 2010). As a consequence there have been very many studies which have investigated it (such as, HEA 2012b, NAO 2007, Trowler and Trowler 2010, Yorke and Longden 2004).

Much of this wide generic engagement literature was of peripheral interest only to this project and was not directly considered. However an informative review of previous work on engagement is available (Trowler 2010, Trowler and Trowler 2010). Whilst this review is a secondary source it provides a valuable summary of issues pertaining to engagement generically. This review identified over 1,000 publications on student engagement, although only a small proportion of it is from the UK. The authors note that much of this body of work takes an essentialist view of students, and assumes 'sameness' in the student population. As their comment suggests, this must be unhelpful since students clearly respond to issues associated with engagement on a personal basis.

Trowler and Trowler (2010) summarise this corpus. Engagement appears to be widely agreed to improve student outcomes and that creating it is a shared responsibility between staff, institution but also the student. They observe that students who are least academically prepared for their studies seem to benefit the most from being engaged. However it seems that some students experience engagement negatively, in that students such as international, racial or religious minority groups or first generation students may feel overwhelmed or isolated despite being well engaged. This latter point must reflect the survey instruments employed but, more significantly, also the definition of engagement adopted. Such students could be considered as not really being fully engaged with regard to their emotional connectedness, a concept discussed in Chapter 7.

Krause's ten principles for the enhancement of student engagement are presented (Trowler 2010):

- create a stimulating intellectual environment
- value academic work and high standards
- respond to demographic subgroup differences
- ensure expectations are explicit and responsive
- foster social connections
- acknowledge the challenges
- provide students with self-management strategies
- use assessment to shape the student experience and foster engagement
- manage online experiences with care
- recognise the complex nature of engagement in policy and practice

These are broad-ranging principles, some of which embrace a diverse range of issues.

This literature review suggests that the local context affects engagement and that "*engagement issues may vary by discipline*" (Trowler 2010:38). Whilst this comment gives support to the decision, in this research, to focus largely on engagement literature from the area of computing, there does not appear to be anything in the summary of engagement as just presented which is not likely to apply to computing. This section continues, still looking at work on engagement generically, and in particular some of the models developed by theorists.

Of relevance to this research, Hu and Kuh (2002) conducted analysis on the large dataset from the US College Student Experience Questionnaire. This covers many areas of student life, including the time and effort spent on various activities, such as study tasks. They found that mathematics and science students, including computing students, were more likely to be disengaged than other students. Also, males are more likely than females to be either disengaged or highly engaged. This is relevant to the current research, with the male gender bias on many computing courses.

Hu and Kuh also reported that, for individual students, a perception that the institution emphasised practical and vocational concerns is helpful to

engagement. Surprisingly though students tended to be less engaged if their collective, 'aggregated' perception was that the institution emphasised these concerns. Hu and Kuh suggest a possible explanation for this apparent contradiction could be that, whilst seeing the vocational relevance of material encourages a student to engage, *"being around peers who are in college primarily to obtain a good job (as reflected by the aggregated measure) may discourage student engagement"* (Hu and Kuh 2002:570). This is significant since in computing emphasising the vocational relevance of material is often seen as a route to motivating it to students.

3.5.1 Routes to student engagement

Many studies of student engagement (or dis-engagement) try to identify its origins and the factors which influence it. What follows is a brief description of a few such studies. It must be noted that some are presented as routes to engagement, whilst others focus on disengagement. It must not be assumed that the former is simply the reverse of the latter: it would be unsafe simply to reverse (to 'negate') the phraseology and expect that the resultant causation is always valid. The studies are described as models, presented in diagrammatic form although most of these authors did not present them in this way. This may be due to their personal writing preferences or perhaps because a diagram can be seen to imply fixed causation. Despite this risk, diagrams are used here to summarise the models of influences, for clarity and comparison. However it should be borne in mind that the relevant authors do not necessarily see the influences as being as firm or direct as a diagram might suggest. They are, after all, influences rather than deterministic causes. Also, no conclusion should be drawn about these authors' views of any other relationships between these concepts. These diagrams reflect their views about the influences on student engagement, only.

Yorke and Longden (2004) reviewed the evidence related to student retention and success, looking at larger scale events than a student's involvement in their course. Indeed they use the term 'engagement' to mean 'persistence' or 'not withdrawn'. Theirs should be regarded perhaps as a 'theory of student

departure'. However the influences which affect student persistence would tend to be similar to those which influence student engagement (in the current sense). Yorke and Longden say that a student's engagement (*i.e.* persistence) is a reflection of their commitment to their course. They also note that students who "*drift into HE*" (*ibid.*:8) without a clear sense of purpose tend to have a lower commitment and thereby less persistence, suggesting that a sense of purpose is the key to persistence (Figure 3-7). This aligns with Hu and Kuh's (2002) view (§3.5) that seeing the vocational relevance of material enhances students' commitment and persistence.

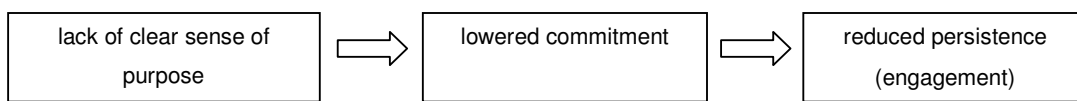


Figure 3-7: Yorke and Longden's Theory of Student Departure
(derived from Yorke and Longden 2004)

However, having painted this general pattern of relations, Yorke and Longden are clear that they do not believe that a 'grand theory' of student retention will ever be possible, certainly not as a predictive theory. Due to the complexity of the range of possible influences on students, they are even sceptical about the possibility of developing an explanatory theory, instead suggesting that a number of constructs are "*worthy of consideration*" (Yorke and Longden 2004:82) in the attempt to identify issues relevant to retention. These constructs include Tinto's theory of individual departure (Tinto 1988); Bourdieu's theory of social reproduction (§3.3); motivation (§3.6) and self-efficacy.

Other researchers have investigated slightly different contributory factors and, of course, generated different models. Bryson (2010) identifies persistence and good learning as stemming from engagement. He sees social and academic integration, as described by Tinto, as being crucially important to a student's engagement. Additionally, Bryson notes that Tinto acknowledged that the concept which he, Tinto, had termed 'involvement' is synonymous with student engagement, in the current usage. Thus, a student's sense of 'belonging', both

socially and academically, will affect their engagement. Roddan (2002) (§2.8) used Tinto's theory in his investigation of first-year computing students and his data suggested that student integration is indeed important for success. However, as well as integration, Bryson identifies that a student's teaching and learning experiences will influence their engagement – positively or negatively (Bryson 2010) (Figure 3-8). Bryson does not incorporate motivation, that sense of purpose, which was central for Yorke and Longden.

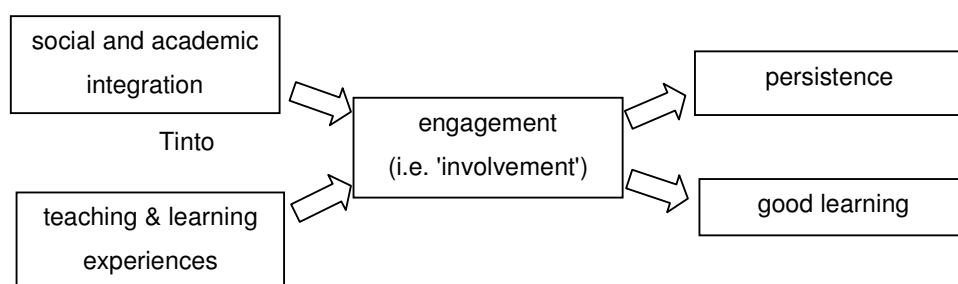


Figure 3-8: Bryson's sources of engagement

(derived from Bryson 2010)

Other models employ self-efficacy, a concept developed by Bandura (2006). Self-efficacy is one's confidence in one's ability to succeed: the "*judgement of competence to perform a task*" (Pintrich 2004:395). It calls on both competence and confidence and is associated with student success. Pintrich reports that a students' view of the value of a task is closely related to whether they choose it (such as which course they apply for and enrol on) but, once chosen, it is self-efficacy that is important for achievement. Black (2003), albeit from rather simplistic data, observed that it was self-efficacy which seemed to be central to computing students' success (§2.8). Similar observations have been made by others, for instance, Haggis (2003) linking academic self-confidence to achievement (and perhaps also to engagement). Purkey makes a similar point saying that some students can, inappropriately, 'get stuck' with a negative view of their abilities. He identifies this as being very damaging to affected students' progress and a challenge for teachers: "*negative self-talk often becomes a self-*

fulfilling prophecy" (Purkey 2000:3). Pintrich (2004) also notes the importance of positive self-talk. Computing courses often recruit some relatively weak students, who may lack academic confidence, for whom this could well be a significant barrier to success, or engagement.

The final model to be described is part of a larger one linking self-efficacy and performance. It was developed by Lent and Brown, based on Social Cognitive Theory, and considers engagement issues at a more detailed, psychological level (Alexander *et al.* 2011) (Figure 3-9).

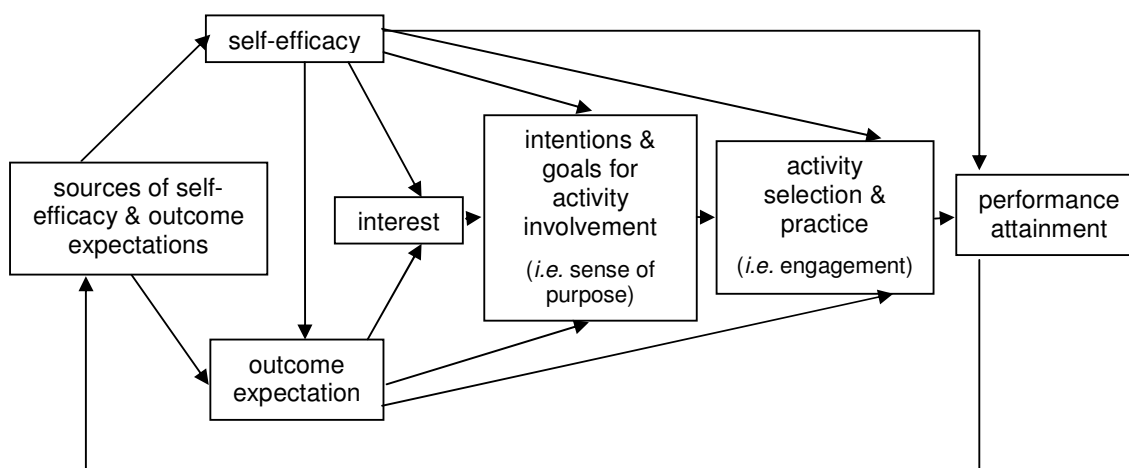


Figure 3-9: Lent and Brown's Model of Engagement

(based on Alexander *et al.* 2011)

Student engagement, in the current sense, is presented here as 'activity selection and practice'. This model identifies self efficacy, interest and outcome expectations as being the significant factors in engagement. Lent and Brown see this involvement, along with self-efficacy, as being key to achievement (performance attainment). From this psychological perspective, achievement can be seen to feed-back, and forms one of the sources of further self-efficacy and outcome expectation, forming a positive spiral of interest and effort which often comes through success (Alexander *et al.* 2011). 'Persistence', which was included in both the previous models, is not represented here, nor is 'commitment'. The 'sense of purpose', the key for Yorke and Longden, is clearly

closely related to Lent and Brown's 'intentions and goals'. This Lent and Brown model does not take into direct consideration 'integration' and 'learning and teaching experiences', which are key in Bryson's thinking, although these would contribute to their 'sources of self-efficacy and outcome expectations'.

No attempt will be made here to further rationalise these, or the many other, models of engagement. What these models show is that engagement is seen as being important to achievement. More directly relevant for the current work, they also point to a number of issues as being important factors in that engagement, including: sense of purpose and interest; social and academic integration; self-efficacy and teaching and learning influences. Student engagement will be discussed in Chapter 7.

3.6 Motivation

The term 'motivation' is used to refer to a variety of different factors between a student and their studies. It is often used quite 'loosely' but in particular it is used to refer to differing scales of phenomena, and therefore takes a range of meanings. As indicated in some of the engagement models, a student's attitude to, and motivation towards, their course is key to their prospects of success. For example (§3.5.1), Yorke and Longden (2004) confirm the intuitive assumption that students who drift into HE without a clear sense of purpose, tend to have lower commitment and therefore are more likely to withdraw from their course. Previous work specifically looking at the motivation of computing students was presented, in the previous chapter.

Some students are not motivated by a deep interest in their subject but have "*an instrumental view of education*" (Sterling 2010:512): a degree can be seen as just a means of getting a job. Practice suggests that this is true for some computing students. In England, from 2006, the government introduced student 'top up' fees of £3000. They justified this by publicising the earnings premium typically secured by gaining a degree. It was a very high-profile issue and subject to major debate. However it was, largely, both accepted and endorsed that

many students wish to gain a degree primarily, if not solely, in order to enhance their earnings potential. Yorke and Longden (2006) investigated many aspects of students' first year experience and found that many students felt that they were not as motivated as they thought they ought to be.

The Lent and Brown model (§3.5.1) shows student motivation as 'intentions and goals' and that it is influenced by self-efficacy, interest and outcome expectation. Pintrich (2004) also takes a psychological perspective and looked at the ways

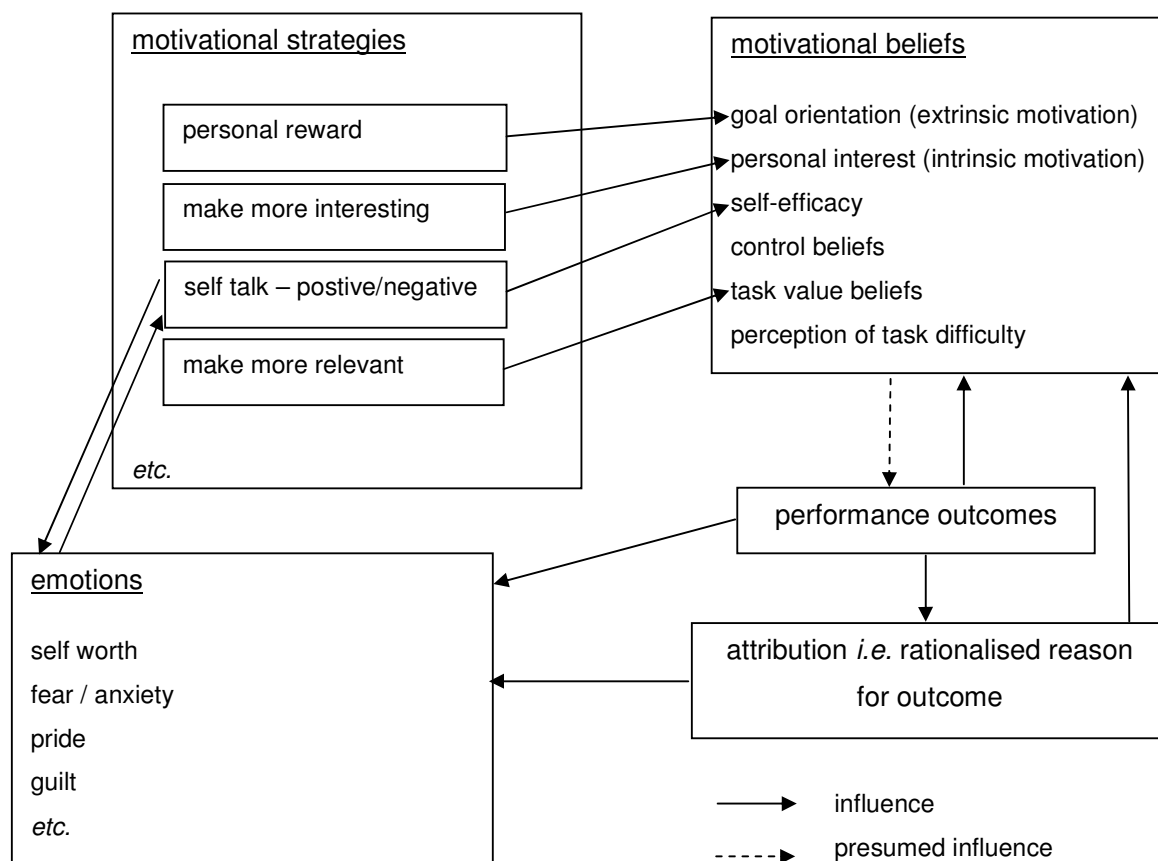


Figure 3-10: Pintrich's Model of Motivation

(derived from Pintrich 2004)

students' regulate their motivation and learning looking at the impact on students' learning of social context, motivational, cognitive and behavioural factors.

Pintrich models these as four separately regulated areas. Of interest here are the motivational factors (Figure 3-10).

Pintrich sees motivation as comprising a number of 'beliefs', including goal orientation (*i.e.* extrinsic motivation), personal interest (*i.e.* intrinsic motivation) and self-efficacy. It is presumed that he sees these collectively as influencing performance outcomes. (As noted previously (§3.5.1), he reports that self-efficacy does so but task value is much less significant.) Motivational beliefs themselves are affected by performance but also by the attribution made for that outcome – the way in which a student rationalises it. A student may also employ a number of strategies to regulate aspects of their motivation, as shown, and these in turn are influenced by, and influence, the student's emotions. Thus, for Pintrich, motivation is influenced by a student's emotions, performance and their regulation strategies.

3.6.1 Measuring motivation

It had been anticipated that motivation would be a significant issue in the consideration of course choice, so one approach was to seek an instrument to measure academic motivation. There have been many attempts to do this (for example, Buckley 2004, Sundre 2000, University of Rochester 2007). Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich *et al.* 1991, 1993) and Academic Motivation Scale (AMS) both provide validated instruments for this purpose. AMS evolved from an instrument initially developed to measure sports motivation (Pelletier *et al.* 1995). Many variants were developed for use in other contexts (Vallerand and Losier 1999), including academic motivation (Vallerand *et al.* 1992). AMS recognises that an individual can have a mix of motivations and determines scores on the three scales: intrinsic and extrinsic motivation and a measure of amotivation (Vallerand *et al.* 1992).

Whilst such instruments stem from a positivist epistemology it was expected that they would provide useful data to supplement participant profiles and to facilitate discussions. No wider use was intended for them. Motivation was used to consider how students view the image of computing (Chapter 5), why they choose to study it (Chapter 6) and issues related to their engagement with their course (Chapter 7).

3.7 Identities

Identity is about being a particular kind of person: it is about 'becoming' something. It is a person's reflexive understanding of who they are. It has two aspects: an internal, self-identity or core identity and multiple external identities which are presented to, or "*performed in, society*" (Gee 2000:99). Both are malleable and subject to change, indeed identity is being "*constantly created and re-created*" (Sfard and Prusak 2005:15), although one's core identity is relatively stable. Gee (2000) notes that people's multiple external identities relate to their roles in society. Referring to core identities it seems, McAdams says:

"identity is not an individual achievement but a work of (and in) culture. In a sense, the person and the person's social world co-author identity" (McAdams 2001:116).

Thus identity is shaped by society as well as by the individual. It provides peoples' lives with coherence and meaning, through evolving narratives and understandings of themselves. It would seem that identity may be linked to self-efficacy, both through confidence in one's abilities in the discipline and through a sense of where one wants to position oneself within that community. Thus it seems likely that the process of developing a clear personal identity in a subject goes along with enhanced self-efficacy.

Sfard and Prusak (2005) distinguish actual and designated identities. The latter is the identity which someone is expected to take either now, or in the future, and to become part of their actual identity. This might include stereotypical or traditional aspects of a profession and, since these are socially generated, they are quite fixed. The student may, but may not, desire to acquire these characteristics but resisting these expectations can be difficult. They are social constructs which constrain personal agency. Solomon, Lawson and Croft (2011) found that a designated identity, such as the relationship of female students with mathematics, is quite binding but that some women do manage to 'refigure' this relationship, creating their own acceptable, mathematical identity.

As we move into a new community we take our identities with us, including aspects and elements developed in other communities (Wenger 2000). We take our habitus (§3.3.2) of values and norms, as well as our capitals (social, cultural and so forth) (§3.3.3): we take our identities. When someone starts a new course, for example, they must develop a way of presenting themselves: mould an external identity, appropriate to a student of that discipline, in that community (Wenger 2000). Learning implies change, becoming a different person and hence constructing a new identity (Sfard and Prusak 2005), which may fit or clash with their existing identities (Case 2008, Dean and Jolly 2012, Bryson 2010). As Case (2008) observes, some disciplines place a high demand on students in this regard. Computing, with an image charged with potentially negative connotations (§2.6), is a case in point. Indeed it seems likely that computing students, like many others, would often not want or expect to need to mould a new identity. They are more likely to view their degree as expanding their knowledge and skill-base but not as character-changing. Identity, particularly designated identities, will be used to investigate the image of IT and its profession and their impact on computing courses (Chapter 5).

3.8 Communities

The concept of a 'community of practice' (CoP) has been widely used in sociological studies. That, and the related idea of a community of learners, is introduced here since the social dynamic of a community will be shown to be important for supporting learners on computing courses. CoPs originated with Lave and Wenger (Wenger 2000) as a way of describing how novices enter a community of expertise as peripheral, but *bona fide*, members. It reflects the classical view of an apprentice learning a trade alongside a master. All are working on a common enterprise, although each may have their own tasks and roles, as befits their level of expertise.

Wenger (2000) describes three elements common to all social learning communities: a sense of joint enterprise, relationship building (or mutual engagement) (*i.e.* norms and mutual trust) and a shared repertoire (or collective

awareness). These require the existence of energy to learn, a strong sense of belonging and the ability to reflect. Learning communities are realised through individuals' identities, through the collective brought by each individual member (Wenger 2000). Differences in identities may lead to tensions within a community, the understanding and resolution of which has the potential to benefit the group collectively and its individual members. However there is a general trend towards the development of shared values and assumptions (Wenger 2000): a shared habitus (§3.3.2) and shared, group identity. Such processes help shape the individuals' identities but they also shape the social structures (§3.4.2), including such learning communities. "*The work of identity constantly reshapes boundaries and reweaves the social fabric of our learning systems*" (Wenger 2000:242).

Community of practice theory is quite often drawn upon in educational research (for example, Wenger 2000, Case 2008). However it might be argued that there are respects in which much of education does not fit the CoP model. In formal education staff are in positions of authority over students, both as guiders of learning and as assessors, to an extent which is more impactful than in many other types of community. Also, CoP presumes that everyone is working towards a common goal through related sorts of activities. In the traditional education model of learner and teacher this is seldom the case. Students cannot be seen as useful co-workers. Even more significantly CoP assumes that the novices will succeed if they mimic the experts: that their task is largely to learn to do and think like the experts do and think (Fox 2000).

In most educational settings teachers and learners undertake very different sorts of activities. Typically the learners are not aspiring to do what the teacher does. They may gain some benefit from mimicking their behaviours and attitudes but that alone is not 'enough' and may not even be necessary. In a school context, pupils do not need to learn the teacher's presentation or discipline or assessment skills. Those will not typically secure the qualifications they aspire to. However through their education they will start to move towards a model of their chosen profession in that they will start to learn the specialised ways of thinking, writing and problem solving of their discipline (Case 2008), as well, of course, as

developing their subject knowledge. In regards such as these, mimicking their teachers is what a learner should do.

Generally this is true in universities too although there are some confounding factors. The academic may be more concerned with research and see their publication list as their real *raison d'être*, with teaching as a side-duty. Students would not figure in such a social set-up. However sometimes students are actively involved in research projects and there may be a real community of practice: people working together, each at their own level, on a common endeavour. Another example of where there can be a genuine CoP in universities is on highly vocational courses which require students to spend periods of time working alongside experienced professionals, learning to be 'one of them'.

For Wenger, communities of practice need: "*collegiality, reciprocity, expertise, contributions to the practice [and a] negotiated learning agenda*" (Wenger 2000:243). However in many educational settings the last two, at least, can be lacking. Typically students make no, or only notional, contribution to practice whilst the curriculum is set and only rarely are students given scope for negotiation. Additionally, in a traditional teaching setting there may be little by way of reciprocity, with students regarded just as recipients of knowledge.

The concept of a community of learners may be more easily applied to some of HE. This has many of the features of a CoP, but it is based on a co-constructivist learning regime. Staff and students are co-learners, learning through dialogue and jointly sharing the responsibility for learning (Carnell 2007). As will be described later (Chapter 8), the idea of community will be seen to be significant in the current study, although perhaps constituted differently from a CoP, or even a community of learners.

3.9 Conclusions

This chapter has presented the three main theories which were used during analysis in this study. Whilst they each offer an ontology, they operate at

different levels and can draw out different types of understanding. ANT provided the prime analytical lens, using a diagramming approach described in the next chapter. This facilitated the initial identification of interactions and influences of various structures, individuals and artefacts on one another. This prime analytical device was supported by the theories of Structure-Agency and TSP which are both people-focused, looking at societal effects. Structure-Agency is the broadest, 'highest-level' lens and is used to look at wide societal influences, impacts on individuals, and their agentic responses. TSP uses concepts which mainly operate at the level of the individual, such as capital and habitus: ideas which inform the way individuals respond and interact. These differences in character mean that they feature to differing extents through aspects of the analysis and interpretation.

Also summarised were 'working' concepts which will be drawn on, when necessary. These were models of student engagement; motivation from both a socio-cultural and a psychological perspective; the concept of identity and, finally, the idea of academic communities.

This chapter has thus presented the main 'general' literature which will be called upon in this study, comprising its conceptual framework. Along with the computing issues, covered in the previous chapter, this completes the introduction of the background material. The next chapter moves on to describe the research itself looking at the methodology employed and the methods adopted.

4 : Digging into Social Issues: Finding Treasures in the Quagmire²¹

²¹ Title based on Finlay (2002)



"Knowledge is always tentative, contested and subject to change – but we can know something, albeit imperfectly" (McArthur 2012:423).

4.1 Introduction

Chapter 1 introduced the rationale for this research and the questions it seeks to answer. It also positioned the researcher as being both inside and outside the research domain, discussing the resultant power differentials and the risks of insider bias. Then, having described the background computing issues and literature, and the conceptual framework employed during analysis and interpretation, the focus can now move on to look at the approach taken to the research, its methodology, execution and methods.

This chapter will commence by looking at the philosophy of the adopted constructivist-interpretive stance. An exploration of the methodology follows, describing the principles used for research design, the stages in the research process, rigour and ethics. A section on the project execution provides an account of each research stage. Finally, discussions of the data collection and other methods are grouped towards the end of the chapter.

4.2 Research Philosophy

In the philosophy of research, a paradigm is a worldview – a *"basic belief system, based on ontological, epistemological and methodological assumptions"* (Guba and Lincoln 1994:107). Before considering the research methodology and methods it is necessary to consider the overall paradigm and philosophical position which guided the current research.

For some aspects of life there is a single reality: specific events happened. It also seems evident that sometimes: *"it is possible to approximate (but never fully know) reality"* (Guba and Lincoln 1994:111). There are some situations where things are so clear, evident and unambiguous that there is little scope for

differences of understanding and it would seem to be obtuse not to acknowledge this. *"There is a world of events out there that is observable and independent of human consciousness"* (Denzin and Lincoln 2005:13), for example, student X did not attend class Y. For some situations there is an incompletely known reality and events are not 'constructed' by its participants, although each may well report it differently. This is the post-positive ontology of critical realism. Critical realists believe that there is a single, real truth but knowledge of it can only be imperfect (Guba and Lincoln 1994). The lecturer may believe that X was absent from class. X may believe he turned up but no-one else was there. Maybe he mis-read the timetable.

Whilst, for the consideration of some sorts of events, critical realism does have an appeal, for much of social life people's understandings of events are personal and constructed. This view is constructivism. When a lecturer sends students away to research a topic, some students might interpret this as the lecturer being lazy, whilst the lecturer may believe they are providing a useful learning opportunity. Of course this is based on different views of lecturers' responsibilities and what makes for effective learning. Nonetheless the lecturer and student might interpret this event in very different ways. People do not experience or understand events in the same way as one another.

"We cannot step outside our own experience to obtain some observer-independent account of what we experience. Thus, it is always possible for there to be different, equally valid accounts from different perspectives" (Maxwell 2002:41).

This project therefore works within the constructivist-interpretive paradigm using:

"a relativist ontology – there are multiple [constructed] realities, a subjectivist, [interpretive] epistemology – knower and respondent co-create understandings" (Denzin and Lincoln 2005:24).

Findings are constructed through the co-work of the researcher and participants. They are subjective but they emerge through a carefully conducted, thoughtful but interpretive research process. Certainly the findings cannot in any objective sense be proved to be true or false: they are what they are. The aim was to achieve a deepened, broader understanding.

For research such as this, which investigated the processes and influences in play around human subjects, adopting this paradigm was the considered best way of generating understanding. Certainly a quantitative project would have led to the identification of the patterns which exist but the need here was to explore the social processes which generated them. A different form of qualitative research could have been used, most obviously a Grounded Theory study. This was rejected because it seemed less useable when the researcher is inside the domain of study. Here a balance was to be struck between viewing from the outside, looking afresh at the data, and using the benefits of insider's knowledge (Chapter 1).

An "*abductive research strategy*" (Mason 2002:180) was used in which "*theory, data generation and data analysis are developed simultaneously*" (*ibid.*:180). Data collection continued alongside analysis, interpretations evolving throughout allowing emerging ideas to be tested and details of the data collection to evolve. This process will be described later (§4.4.1). Having established the adoption of the constructivist-interpretive paradigm, consideration of the methodology employed follows.

4.3 Methodological Concerns

4.3.1 Methodology outline

The purpose of this research was to gain understandings of students' and school pupils' opinions and attitudes. The initial research objectives and emergent questions have been discussed (§1.2). To establish if the identified issues were widespread concerns, firstly a preliminary study was conducted, talking to other academics. This is discussed later (§4.4.4), with the range of other studies undertaken. The research overall aimed to investigate pupils' views and perceptions and what reasons, aspirations and views led to their decision to apply (or not) for a computing degree and how they viewed their course once enrolled. This suggested working with applicants over an extended period. One study did exactly that, with the longitudinal participants remaining in the study for

up to 18 months, from 15 months before their university entrance until the end of their first term.

Of course, the research needed to be conducted over a relatively short time-period and so, in order to capture a broad set of views, the strategy was to introduce other studies as the need and opportunity were detected, generating data of a broader, cross-sectional nature. The organisation and management of all these studies is described later, (§4.4.4). However, in summary, there were six studies in total:

- The preliminary study talking to fellow academics.
- The 18 month longitudinal study with applicants.
- Focus groups with newly enrolled first-year students.
- Weekly research sessions with first-year students, where the activities had been carefully aligned with an assessment – an 'in-module' study.
- Since dis-engagement was an issue of concern, interviews were held with disengaged students.
- An opportunity arose to access students' views of the image of computing – the image study.

Other than the preliminary study with academics, these studies all worked with pupils or students investigating their personal views and experiences. However it was recognised that there are other people involved in course choice, who could have provided interesting perspectives on the issues under consideration. In many families parents were influential in course choices and their views could have been sought; teachers and careers advisors likewise. Recruitment staff in HE could have been involved. Early thinking had been that such groups could be involved in this project but in the event the restrictions on time meant that only pupils and students were included. It would be informative though to cross-check the findings of this research with such people.

Whilst this research was primarily about how potential students make their choices and how that fits the reality of their courses, it could have been more focussed on the student experiences. However that would have been a very different project and would have needed to directly investigate teaching and learning issues. Although some such matters arise here, they are largely a peripheral concern.

This project aimed to gain understandings and develop what Geertz (1973:3) calls *"thick descriptions"*. Whilst a superficial view of student perceptions and motivations can be gained using questionnaires and so forth, it was evident that to secure a rich, deep understanding data collection would need to be designed around a close involvement with relatively few participants, using some form of narrative. To encourage elaboration and facilitate understanding, some form of interaction with participants would also be needed. Therefore, where appropriate, semi-structured interviews were used. However it was also desired to make participant engagement more varied, particularly important to retain the interest of longitudinal participants. The strategy adopted was to have monthly engagements with them (although avoiding their examination periods) and, after an initial life history interview, to conduct interviews at their decision key points (UCAS application deadline; offer response deadline; A-level results and clearing). For other months there would be some activity which they might find less burdensome and intrusive, but which would also provide useful research data. Thus the project used a wide mix of methods, creating a *bricolage* (Denzin and Lincoln 2005) of data, to enrich the understanding of participants' choice-making (§3.1.2). These methods, and the studies in which they were each employed, will be described later (§4.5) and (§4.4.4).

Concerns are sometimes expressed about the theoretical underpinnings when using multiple methods: *"if you treat social reality as constructed in different ways in different contexts, then you cannot appeal to a single 'phenomenon' which all your data apparently represents"* (Silverman 2005:121). Here, using multiple methods to enliven understanding, no such tensions were detected. Methods were used with a critical awareness. Many methods involved at least some dialogue with participants. This allowed issues to be explored and

understandings secured. Where appropriate, the results of the methods which employed a formal test were also discussed with participants, allowing the participants to better understand their meaning but also to explore their reaction to them.

Not all aspects of data collected have been drawn upon in the analysis. However all were useful, even if only to help keep participants 'on board' the project, although this was never the sole reason for using any of them: to do so would have been ethically questionable. A summary is provided of all data collection methods (Appendix B), those which were used in the analysis are fully described (§4.5), as are the studies in which they were employed (§4.4.4).

As part of research design it was decided to select a number of concepts and theories to assist with the analysis: the conceptual framework. Whilst these have already been discussed (Chapter 3), others could have been chosen instead. Most obviously, the concepts presented as lesser, working concepts could have been foregrounded but almost any sociological theory could have been used, though to widely differing effects. The selected concepts and theories were chosen since they seemed to complement one another, providing alternative perspectives, without seeming to be in tension in terms of underlying assumptions and philosophies.

4.3.2 Ethics and risks

Ethical approval was granted for both the preliminary and main studies (Appendix E). Also there are the Participant Information Sheets and Consent Forms submitted as part of the approval process, variants of which were created to address issues related to specific research studies. All participants completed the consent process. Participants under age 18 also provided their parent's agreement via a section on the consent form.

The required Risk Assessment was completed. In addition, because it was possible that school visits or interviews with under-18s might be needed, Criminal Records Bureau (CRB) clearance was also gained.

Two sets of guidelines informed the ethical management of this work: those from the British Educational Research Association (BERA) (2004 version)²² and the Association of Internet Researchers (AOIR) (2002 version)²³.

4.3.3 Striving for rigour

Throughout the research the aim was to maintain appropriate quality and rigour. Hence efforts were made to ensure credibility (Denzin and Lincoln 2005), authenticity and trustworthiness (Guba and Lincoln 2005). Grounding findings in "*thick descriptions*" (Geertz 1973:3) and other data, which were co-constructed with participants, affords this thesis authenticity by reflecting participants' accounts. Credibility of analysis and interpretation was achieved through regular cross-checking and questioning, but informed by the theories in the conceptual framework. Insider knowledge was useful in this regard, permitting interpretation within a familiar context, although being careful about its application.

Trustworthiness was secured through the reflexive, balanced and, as far as possible, unbiased analysis and interpretation presented over the next few chapters where some relevant concerns are discussed. For example, some member checking was done, with the intention of enhancing rigour (§4.5.2). Transparency is achieved by carefully describing the approaches used and presenting findings through participant quotations and other data. Thus this thesis will hopefully be considered to have the necessary rigour.

²² http://www.bera.ac.uk/system/files/ethica1_0.pdf

²³ <http://aoir.org/reports/ethics.pdf>

4.4 Research Execution

4.4.1 The research process

The research process is shown in a flowchart (Figure 4-1). In presenting the process in this way it should not be inferred that this was 'the plan' at the start of the project. The general nature of the stages involved was recognised, however the detail of their interactions was not.

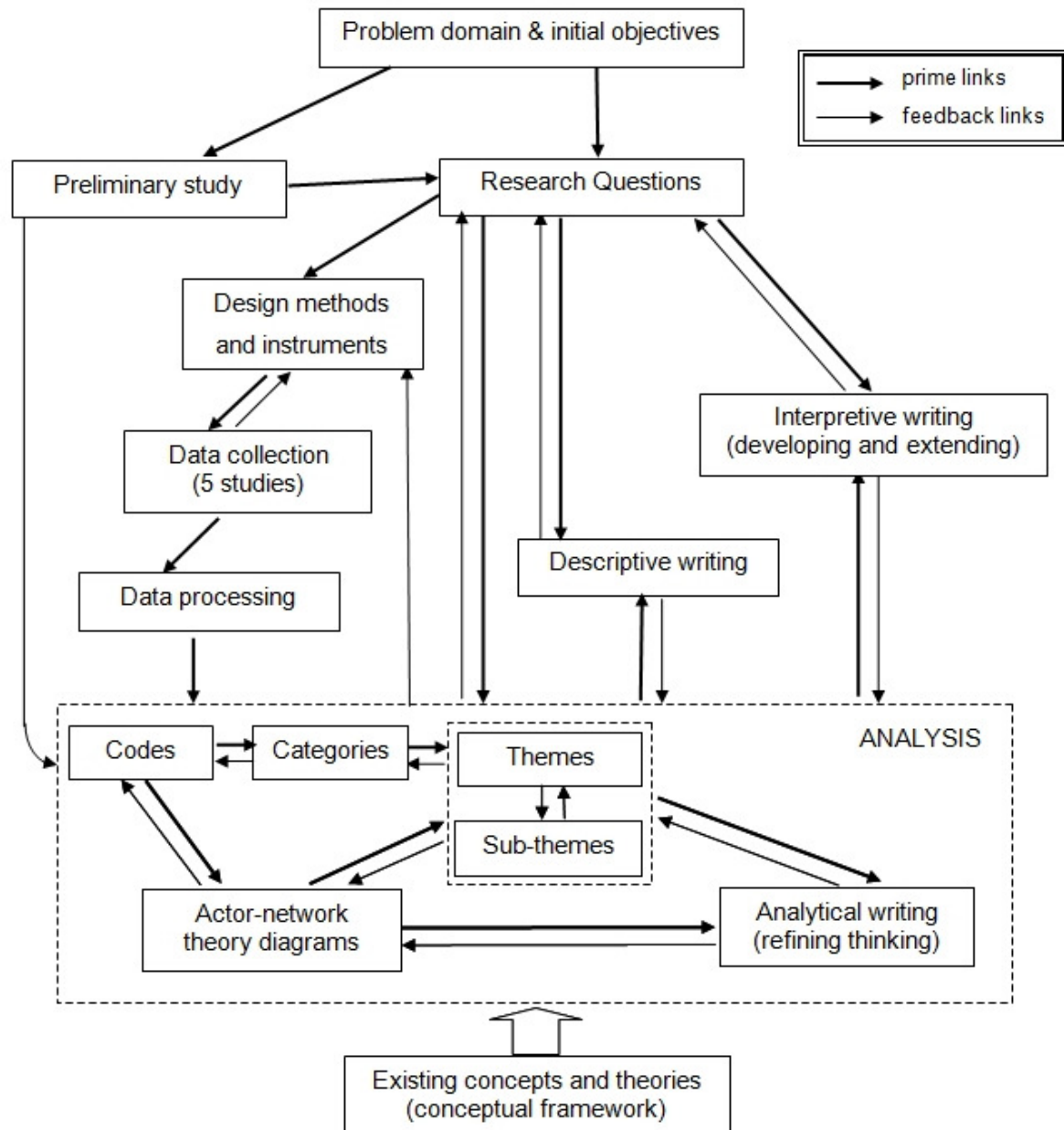


Figure 4-1: This research process

Very few of the connections between stages shown were 'one-off' transitions, but rather most of the process was iterative and stages subject to adjustment and change, with numerous re-visits and feedbacks, as indicated. This is largely a consequence of the abductive strategy adopted which supports re-visiting tasks, for example, modifying the data collection in the light of ideas emerging from the analysis. Presenting the process as a flowchart seems the clearest way of giving the reader, as honest an account as possible, of the messy process of creating this thesis. This account of the project will proceed by broadly following the stages shown in this flowchart.

4.4.2 Research Questions

This project commenced with its general domain defined and an initial objective. The specific research questions which served to focus investigations evolved and can be considered to have emerged through the research. This has been discussed earlier (§1.2). The final questions were:

What influences students' choice, perception of, and engagement with, computing courses and what are the implications for Higher Education in England?

- *How do young people perceive the image and nature of computing as a subject and profession? This includes how they relate to computing personally and the stereotypes of 'nerd' and 'geek'.*
- *What factors lead school pupils to choose to study a computing course at university? This includes the extent to which it is an active choice and the sources of advice and information which they use.*
- *What leads to some computing students to seem to disengage from their course? This includes the factors which affect engagement and how disengagement is represented.*

4.4.3 Design of Methods and Data Collection

There are a number of matters concerning data collection to discuss, including the multiple studies within this project, the methods used in each study and issues related to participants, such as their selection, and the resulting data corpus. A description of the data collection methods themselves is covered later (§4.5).

4.4.4 The research studies

Overall, a total of six threads or studies were conducted. The benefit of using a number of studies was clear as research work progressed. The main package of research, working with pupils and students, comprised five pieces of work which can be considered to be separate research studies. As described earlier (§4.3.1), these studies were designed for different purposes and to exploit identified data collection opportunities. These studies will be described in turn. The methods used in each study are covered later.

Before the main package of research could be designed it was considered judicious first to investigate whether the problems which were perceived were also experienced by other academics. Do others also have some students enrolled on their computing programmes who seem to have no interest in their course and do they have some students who are disengaged from their studies?

The Preliminary Study

A preliminary study was undertaken, interviewing computing academics at Coventry University and elsewhere, about how they saw things. Semi-structured interviews were conducted with 19 academics across the range of types of English universities. (Their profiles are in Appendix A, Table A-2.) Some participants for this study were recruited at the HEA Information and Computer Science Conference (August 2010), and thus from amongst computing academics who are interested in education. Some were professional contacts and some were teaching-focussed computing colleagues at Coventry. There was a range of participants but all were experienced teachers or course managers, people well-placed to know their students. Most interviews were conducted in person although a few were conducted via email. The interview schedule used is in Appendix D. These interviews were all fully transcribed.

The key finding was that all participants reported at least some students who were not really engaged with their course or who had been surprised by some aspects of course content, although at some institutions such issues seemed to be confined to specific sub-groups of students or courses. Concerns about

student disengagement and expectations were clearly widespread-enough to merit serious investigation. In addition to providing a *bona fide* for the overall project, this initial study helped clarify some useful research directions. Three other points which were raised as being of particular concern to some:

- the inconsistent naming of degree titles between universities was seen as being problematic for student recruitment;
- some universities have difficulty in providing industrially-relevant software for student use (due to resource constraints); and
- the lack of even reasonably modern, practical computing skills content in some degrees.

Longitudinal Study

The main thrust of the project was the study of attitudes and opinions over the period during which pupils choose and apply for a degree course, through to when they are, hopefully, assimilated onto it. Therefore a longitudinal research study was set up. Participants were recruited by talking to potential applicants visiting university Open Days. These were mostly pupils late in Year 12. For such pupils recruited in spring/summer 2011 this meant participation for up to 18 months, through to December 2012, at the end of their first term at university.

Most of this recruitment was done at Coventry although another university did very generously permit recruitment at theirs too. At the Open Days themselves pupils were asked for 'expressions of interest', information packs were sent out and completed consent forms returned by post. It was important not to try to secure consent in the pressure of a busy Open Day when, rightly, pupils should be focussed on their course choices. Seventy-five consent forms were sent out but only 12 were returned. Email reminders were sent when possible, in case the paperwork had been overlooked. Whilst a good conversion rate had not been expected, this was disappointing. It is very easy to agree to have some information posted to you, but that does not necessarily reflect any genuine interest. A request for participation was also sent to local partner schools,

resulting in a 13th participant. One participant withdrew during the study, despite having made several contributions over the previous six months.

The prime data collection method used in this study was the interview: up to 5 conversations were held with these participants. However as shown in Table 4-1, over their 18 month participation other methods were used too. These methods are described later (§4.5). They were selected to enrich the understanding of participants' viewpoints. In the event, data was not used from all the methods employed (see Appendix B). Primarily this was because it was not germane to the emerging themes. However all the activities at least served to provide a regular engagement with these pupils, sustaining their participation.

This study provided some insight into the image computing holds for these school pupils. However its main benefit was in generating an understanding of the way in which these pupils chose their academic discipline. It afforded an in-depth exploration of their educational and family background, allowing the core influences on their choices and choice-making to be investigated. The study's duration provided the opportunity to detect any changes in participants' views.

Although it was clear quite early that this study was not generating many participants, it was preferred since it allowed the capture of contemporaneous accounts of pupils as they made their choices which were therefore not vulnerable to the *post hoc* re-interpretations and rationalisations of other approaches. However to ensure an adequate corpus of empirical material two other studies were set up early.

Focus Groups

At the start of the academic year, in September 2011, new entrants were approached and four focus group meetings held over the subsequent 10 days. Whilst 24 students volunteered, 12 actually attended. Again, this was rather disappointing particularly since the meetings had been planned to fit conveniently between their scheduled sessions. The management of these sessions is covered in the discussion of group meetings (§4.5.3). The schedule used is in Appendix D. Data collection in this study was mostly through the

conversation at focus group meeting itself. However the image collection method was used during these meetings to prompt and develop discussion about their views of the image of computing. Some months later these participants were invited to individual interviews to explore the development of their thinking, in private, as they became settled into their course. These data collection methods are all described later (§4.5).

This study provided some insight into how these students had chosen their discipline. However the group format was more valuable for investigating views and opinions and in particular, through the image collection presented, in determining how they view the image of IT as a potential profession. Participants were able to add or contradict articulated opinions or to offer their understanding on salient issues.

In-module Study

The other research study which was set up at this time was based on a pre-existing module assessment and referred to as the 'in-module' study. As part of a module in professional skills, students are required to produce a reflective Personal Development Portfolio (PDP). The module leader agreed that a variant assessment could be issued to research participants which clarified how items created within the research could be incorporated into their PDPs. The participants met in small groups, weekly, over a six-week period from late November. Eleven students were expected although only seven made any contribution, which was surprising for an activity promoted as supporting an assessment. The management of these sessions is covered in the discussion of group meetings (§4.5.3).

Sessions were structured around a series of activities and follow-up discussions. In addition, participants were invited to attend an individual review at a later date in order to explore their views in a private setting. These activities are shown as separate methods in Table 4-1 and each is described later (§4.5). (Some methods did not contribute to the analysis. These are included in an expanded version of Table 4-1, in Appendix B.) The activities were designed to gain an understanding of how and why individual students chose computing and how

they viewed the discipline. They were quite diverse in character, in order to enhance participant interest, but also quite wide-ranging in the issues they address to create broad profiles of the individuals.

Some of the activities in this study explored how and why students had chosen computing. Other activities focussed on the image of computing allowing the important features for individual participants to be identified. Some of the discussions with these participants were useful in understanding aspects of student behaviour, which in turn informed thinking on student engagement.

Engagement study

As these studies progressed, it became very evident that these participants were 'good' students who were reasonably well-engaged: views of the less-engaged were needed. Course tutors identified students they thought were disengaged who were then invited to participate. Personal tutors were asked to identify potential participants and refer them on. Also, at attendance interviews with administrative staff, students with an appropriate background were asked if they would be willing to engage with this research. It was made very clear to all these students that participation was entirely voluntary and confidential. All these recruitment mechanisms led to some additional participants. Overall, nine 'engagement' participants were recruited, from across the years of study. These participants undertook a single interview only. The schedule used in is Appendix D. As will be discussed later (Chapter 7), many of these participants were not in any sense dis-engaged from their course, although some did provide useful inputs. Unsurprisingly, no-one was fully disengaged.

Image study

An opportunity arose to collect some relevant material over the summer of 2012. The Higher Education Academy Science, Technology, Engineering and Mathematics (HEA-STEM) group launched a competition asking students to submit a picture or photograph which captures the image of their subject and might motivate others to study it. Since the 'image' of computing was emerging as a significant matter in this research, the HEA contact kindly agreed to pass on

any submissions related to computing courses, where the submitter gave their permission for it to be used for this purpose. This is the 'image' study. Twelve images were received, although the content of only four of them was relevant. Supported by any accompanying text, these images allowed the identification of some issues germane to the way computing is viewed by those computing students.

4.4.5 Project scope and participant eligibility criteria

As introduced earlier (§1.6), the project aimed to investigate concerns about computing students and, whilst those concerns were relevant to computing students generally, it was decided that it would be clearest, and reduce confounding factors, to focussing research on students taking core technical 'computing' courses. However, since courses are somewhat inconsistently named (§1.5 and §2.4.1), it would have been ill-advised to put too tight a boundary around the focus. The decision was taken to focus on core technical development courses, typically entitled Computer Science, Computing, Computing Science or Software Engineering – which can be seen as being similar in nature to each other – but to avoid specialist variant, business-focussed and joint courses. Such a focus would assist with clarity and avoid confusion from the somewhat different interests, motivations and backgrounds of students on other courses. (The terminology adopted to refer to different groups of computing course has already been discussed (§1.5).)

In the event it proved impossible to exclude other students. For example, at pre-recruitment Open Days visitors are not necessarily clear which course(s) they might apply for. However, the main area where this was a problem was with recruitment to the 'in-module' study (§4.4.4). This involved working with students on a series of activities that supported their assessed portfolios. The research tasks could have been used as part of the evidence in their portfolio and the feedback and group discussion had the potential to significantly enhance their submission. It would have been unethical to give a potential advantage, in that module, to students enrolled on some routes only. Therefore students on all courses involved in that module were offered the chance of participating in that

study and a number of the resulting participants were not enrolled on a core computing course (Appendix A). During the analysis of findings this diversity was taken into consideration.

It was also clear that issues related to overseas and international students, including students from elsewhere in Europe, would probably be very different from those of 'home', UK students and it was the experiences of, and influences on, British-educated students, of any ethnicity, which were sought as the cohort of prime concern. Within that specification it was recognised that different cultural or ethnic groups might have very different attitudes to educational matters which would have an effect. By seeking to avoid overseas students it is not to suggest that they did not exhibit features of concern. However differences in their background would impact on their expectations and experiences. Consideration of influences on such students would need to be explored separately and by regions-of-origin. Thus, where it was ethical, explicit attempts were made to avoid international students too. However it became clear that the university student records cannot reliably make the required distinction. For many life-reasons, a student may be registered with a UK home address, recorded as domiciled in the UK, as a British national and paying 'home' fees and yet be international in their upbringing, experiences and expectations. As a result some participants are international (see Appendix A). Again participant background was kept in mind during analysis.

The low representation of females in computing (Chapter 2) represents an enormous loss of skill to the profession and a lost opportunity for suitable women. It would seem to be impossible to overstate the importance of this. Despite that, gender issues are not a prime concern here. However it was believed that whatever deters some men from entering computing is also likely to apply to some women. With that in mind some attention was paid to gender-based, previous research. Participants were of both genders but differences in their responses were not explored.

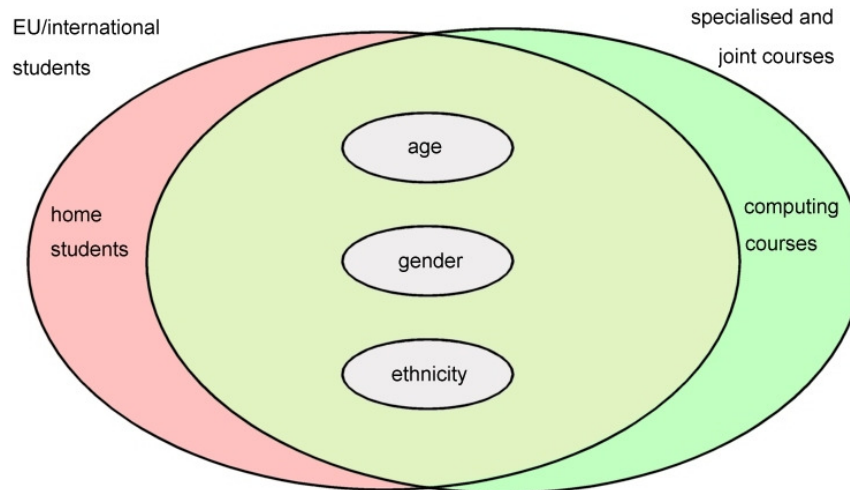


Figure 4-2: Target student participants

Computing courses always attract a few mature students. Whilst their attitudes can be somewhat different to that of the school-leaving, 18-year-old it was decided to include them in the study as they could provide a useful, differently nuanced perspective. Thus the selection criteria for target participants were: of any age, ethnicity and gender and ideally 'home' students, who are on or interested in a core computing course. This is represented in a 'malformed' Venn diagram (Figure 4-2). There is no part-time, undergraduate provision at Coventry so participants were all full-time students.

The gender and course type of participants are shown in Figure 4-3 (although not those from the image study where this data was not available nor those from the preliminary study of academics where it is not relevant). This figure represents the 38 participants in these four studies. (Three participants were involved in two studies.) Over the five main research studies there were 42 participants, with an additional 19 in the preliminary study. A brief profile of each participant is provided in Appendix A.

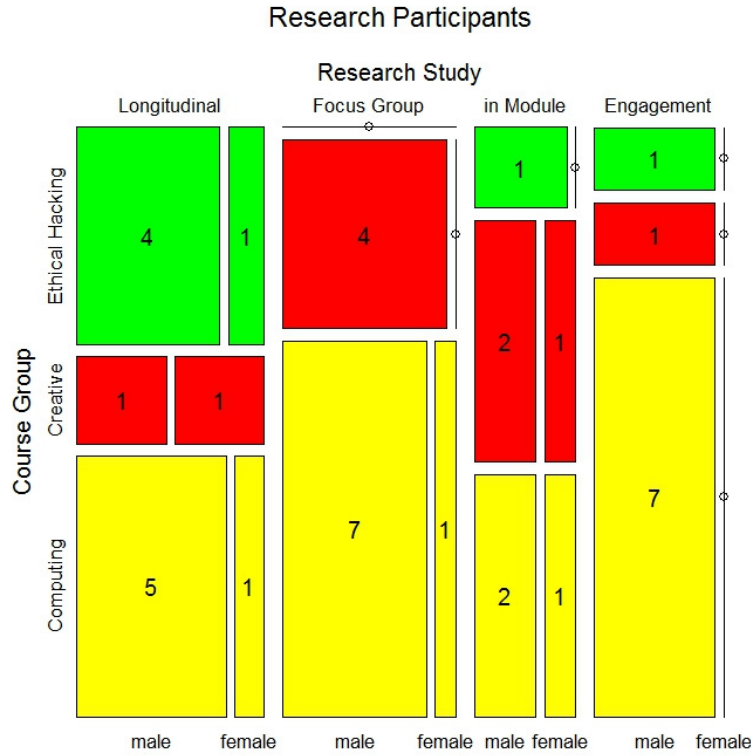


Figure 4-3: The composition of research participants ^{24 25}

4.4.6 Participant sampling

The concepts of participant selection and sampling seldom proved relevant. In general all volunteers, who fitted the eligibility criteria, were recruited. It would have been preferable if there had been more volunteers since this would have permitted the purposive sampling of participants. Such sampling allows maximisation of diversity of participants and thereby has the benefit of capturing the richest set of data (Hou *et al.* 2006). However using volunteers as participants also requires caution both because they are unlikely to represent the entire population in significant respects and because they may volunteer because of some personal agenda (Hewson *et al.* 2003). Indeed as described

²⁴ Mosaic plot created using the R statistics software

²⁵ N=13 Longitudinal; =12 Focus Group; =7 in-Module; =9 Engagement. (Sum = 41 but, due to three participants contributing to two studies, a total of 38 participants represented.) Excludes the 4 image and 19 preliminary study participants where this data is not available.

(§4.4.4), perhaps predictably, the initial volunteers included no disengaged students. Both features required caution to be exercised during analysis.

The participants came from a wide range of backgrounds: some quite 'privileged' and some clearly not. Most had come to university directly from school although some had been at a Sixth Form College and some a college of Further Education. Some were mature and had had a break in education and some had gained entry through an Access qualification. Most had A-level qualifications but some had taken vocational alternatives. During analysis care was taken to avoid a middle-class, 'grammar school' view of education and the educational system, although for clarity discussion will mostly be couched in terms of A-levels and school. Whilst this is not usually intended to exclude these alternative routes to university some of the detailed issues may differ slightly.

From an early stage student engagement was clearly an important issue. The creation of a separate study to focus in on it can be seen as both purposive sampling – providing a body of evidence from a particular group – and theoretical sampling – following an area which was emerging from early work as being significant (Urquhart 2013). Names of potential 'engagement' participants were identified by course tutors but careful consideration was given to the evidence-base to decide if that individual might have a useful life-history to offer. This was purposive sampling, needed since the earlier engagement interviews had become very repetitive. Borrowing the terminology of Grounded Theory, there was a sense of saturation.

4.4.7 Participant engagement tactics

Since it was recognised at an early stage that it would be a challenge to retain participant interest over a long period of time, particularly the longitudinal pupils, a number of tactics were adopted. Efforts were made to try to establish and maintain a relationship with these participants. The aim was to present informally, with a friendly face, but for a purpose which was serious and, crucially, to respect and value participants, their time and contributions, without appearing overly-familiar. To this end, after receipt of a contribution, a 'thank

you' email was sent which included a humorous or interesting cartoon, *YouTube* video, or similar.

As an incentive longitudinal participants were told that they would be entered into a Prize Draw if they remained in the project until its end. It is not clear that this provided an incentive to remain, although it may have swayed some in their initial decision to participate.

A project website²⁶ was built, intended to be used in a number of ways, but most particularly as a link to remote participants. It was used quite heavily, as a repository, to support the 'in-module' participants. Most of the website is open and public although a registration/log-in system was built to allow some elements to be kept private. The intention had been to use private blogs for the discussion of interesting issues. This part of the site was never launched. For a similar effect, a Facebook group was set up which allowed participants to comment, privately to that group. Some participants did sign up for this and some slight use was made of it. More use could probably have been made of these facilities.

4.4.8 The data corpus

Each of the research studies used a range of data creation and collection methods, varying between studies according to circumstance and purpose. The generic methods of interviews and focus group meetings were supported by a number of other methods, most of which were employed to elaborate the participants' profiles. The methods used on each study are shown in Table 4-1. Of course not all participants contributed to all activities on their study so the number of data items from each varied. The volume of data collected in the corpus is indicated in Figure 4-4.

Some attention was needed in re-using methods across studies. For example, three participants contributed to both a focus group and the in-module study so the image collection activity could not be repeated. The methods used in each study are shown in Table 4-1. This table shows all the methods which were used in each study, which were subsequently used in the data analysis. These

²⁶ <http://babbage.coventry.ac.uk/csx067/why/index.asp>

methods are described later (§4.5). The methods from which the data were not used in analysis are only very briefly explained, in an expanded version of Table 4-1, presented as Appendix B.

Method *	Research studies					
	Preliminary	Longitudinal	Focus Groups	In-module	Engagement	Image participants
1:1 Interview	✓	✓	✓	✓	✓	
Group meeting			✓	✓		
Image of computing instruments						
Image competition						✓
Image tagcloud		✓		✓		
Wordle™				✓		
Image collection			✓			
'Images of Computing' scrapbook		✓		✓		
Career and choice instruments						
How did you decide: Pyramid of career influences		✓		✓		

* Methods used in the analysis only. All methods are shown in Appendix B.

Table 4-1: Methods and studies

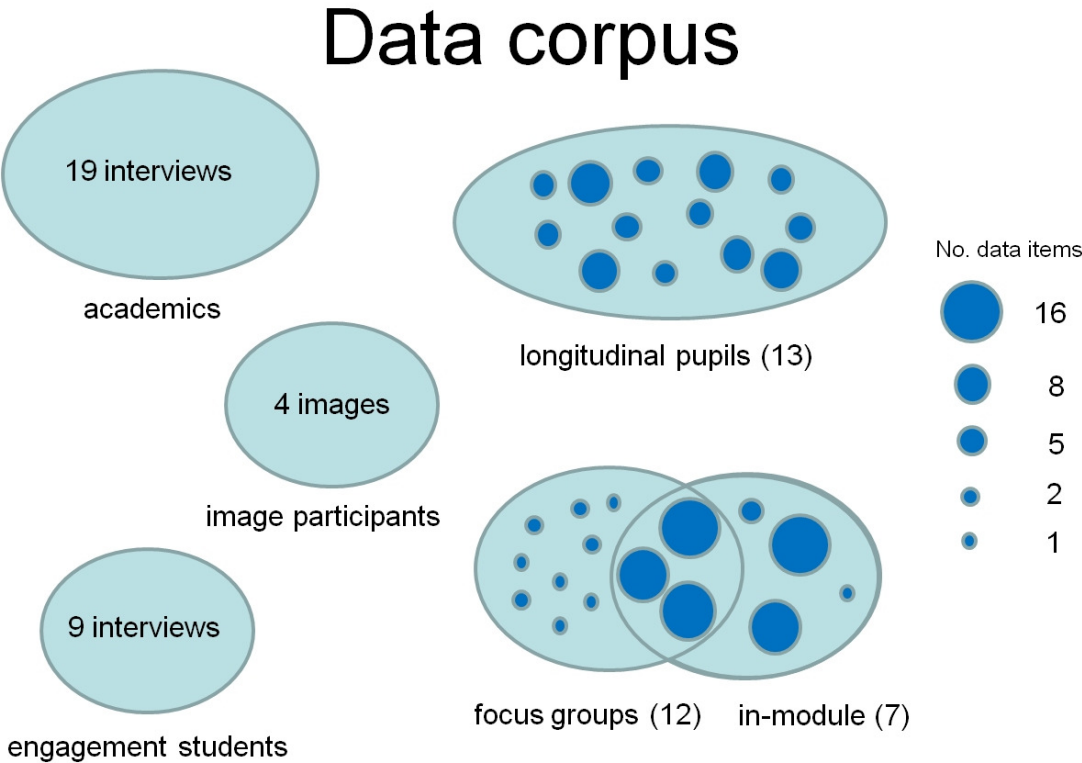


Figure 4-4: The data corpus ²⁷

The methods which generated data from each participant are shown in Table 4-2. This table does not quite correspond with the data corpus diagram since the latter includes all data collected, including that which did not form part of the analysis.

²⁷ Counts all data sources, including those which were not used in the data analysis and therefore not included in Table 4-1 or Table 4-2.

participant		study	method *									
pseudonym	code		No. 1:1 Interviews	No. Group Meetings	Image competition	Image tagcloud	Wordle™	Image collection +	'Images of computing' scrapbook	How did you decide: pyramid of career influences	Total number of data items used in analysis	Total number of data items generated ++
all 19 preliminary study participants	A1- A28	Preliminary	1								19	19
Alex	L3	Longitudinal	5			✓			✓	✓	8	11
Arthur	E8	Engagement	1								1	1
Avtar	F34	Focus Group		1				✓+			1	1
Carl	F21	Focus Group	1	1				✓+			2	2
Charlie	L10	Longitudinal	1			✓					2	4
Chris	F43	Focus Group		1				✓+			1	1
Dave	L2	Longitudinal	4			✓			✓	✓	7	10
Dee	E1	Engagement	1								1	1
Emma	L1	Longitudinal	4			✓			✓	✓	7	10
Ez	E7	Engagement	1								1	1
Farouk	F22	Focus Group	1	1				✓+			2	2
Fidel Angel	E5	Engagement	1								1	1
Imogen	I1	Image			✓						1	1
Innocent	F41	Focus Group		1				✓+			1	1
James Anderson	E4	Engagement	1								1	1
Jason	L13	Longitudinal	2								2	3
Jay	M13	In module	2	5		✓	✓		✓	✓	11	16
Jessica	L8	Longitudinal	3						✓		4	7
Joey	L14	Longitudinal	2			✓					3	4
John	F11	Focus Group	1	1				✓+			2	2
Justin	F42	Focus Group		1				✓+			1	1
Les	I11	Image			✓						1	1
Martin **	M12 F44	In module	1	7				✓+		✓	9	14
Matthew	F12	Focus Group		1				✓+			1	1
Michael **	M22 F31	In module	2	5		✓	✓	✓+	✓	✓	11	16
Myndtrick	M23	In module		3						✓	4	4
Neil	L7	Longitudinal	1			✓					2	5
Nhoj Xela	E3	Engagement	1								1	1
Nick	E2	Engagement	1								1	1
Nicole	M21	In module	2	6						✓	9	14
Omar	F32	Focus Group	1	1				✓+			2	2
Pete	E10	Engagement	1								1	1
Raith	I12	Image			✓						1	1
Rebel	L12	Longitudinal	2			✓			✓		4	6
Richard	E6	Engagement	1								1	1
Rustyrose	L6	Longitudinal	1			✓					2	4

Scarab	L11	Longitudinal	3					✓	✓	5	8
Sunny	L9	Longitudinal	1			✓				2	4
Tad	M14	In module		1					✓	2	2
Teken	L4	Longitudinal	3			✓				4	6
Trevor	I5	Image			✓					1	1
Victoria **	M11 F33	In module	2	7		✓	✓	✓ ⁺	✓	13	17

* Methods used in the analysis only. All methods are shown in Appendix B.

** Participant took part in a focus group, in addition to the in-module study.

⁺ This method does not add to the number of data items generated.

⁺⁺ Total includes data items generated but which were not used in the analysis.

Table 4-2: Methods and participants

Having discussed issues related to data collection, such as the research studies, participants and the resulting data corpus, the remainder of this section will describe the other activities in this research project, stage by stage.

4.4.9 Data processing

Once collected the data were transformed by a series of tasks, collectively referred to as 'data processing' (Wolcott 1994), such as compiling key issues as participant profiles and the transcription of interview and focus group recordings. Issues concerning transcription will be discussed later (§4.5.2).

Participants were known by both a code, for internal record keeping, and a pseudonym, for reporting purposes. Participants were asked to choose a pseudonym and many did so. However some participants did not respond or replied that they did not mind what name was used. For these, a name was chosen: a name which was gender-appropriate and was, hopefully, racially sensitive. The acceptability of these chosen pseudonyms was checked with participants: no-one dissented.

4.4.10 Data Coding and Analysis

The coding process used largely mirrored the method of thematic analysis, as described by Braun and Clarke, which they refer to as being "*a foundational method of qualitative analysis*" (Braun and Clarke 2006:78). The process, which they refer to as analysis, has six stages. The first stage is to familiarise yourself with your data. For transcripts which the researcher herself transcribed that

activity well-served that requirement. The second stage is to generate initial codes and stage three is to search for themes within the codes. Reviewing the themes and then defining and naming them are seen as the fourth and fifth stages. Braun and Clarke see the final stage as being producing the write-up.

Annotated transcripts and data images were loaded into ATLAS.ti qualitative data analysis (QDA) software. Coding commenced with identifying issues which looked as though they may be significant to the research objectives and emerging themes. Some codes related to the explicit, overt meaning of the text but others to covert meanings or implications. The codes used were restricted to features emerging from the text: there were no *a priori* categories (Bryman and Burgess 1994a). However, as an insider you cannot 'unknow' what you already know: you can merely endeavour to be aware of its influence (§1.3.3). Therefore attempts were made to engage with the transcripts with fresh eyes: to try to see things as an outsider. However, "*an open mind is not an empty head*" (Dey 1993:237) and, inevitably, previously-held views and opinions had an impact, guiding both in useful and productive ways, as well as, potentially, to blinker.

The transcripts of the four focus group meetings were coded first since they were the richest of the engagements and therefore likely to be the most productive of those which were available at an early stage. "*Coding is seen as a key process since it... represents the first step in the conceptualisation of data*" (Bryman and Burgess 1994b:218). Having coded all four transcripts they were all re-read and additional codes added where necessary to ensure that all types of element which might prove valuable had been identified. It is recognised that it is possible to just continue coding text (Richards and Richards 1994), with ever-diminishing returns. So, having been through each of these data items twice, it was considered appropriate to move on. In some projects a second person re-codes data. However that was not possible here: this was a single-person project. Instead the reliability of coding was enhanced by this re-reading of the text, re-evaluating the codes.

Work started early on coding the focus group transcripts with many of the other data items coded later. Existing codes were reused; sometimes new ones

needed to be created or existing ones sub-divided. The later coding focussed on the emerging themes of interest. Early codes also allowed tentative ideas to be formulated of issues and themes, which in turn led to some additional coding of the data. This was a creative and iterative process as indicated in Figure 4-1.

For Braun and Clark (2006), the third stage of analysis is to collate codes into potential themes. (Braun and Clark do not use intermediate groupings as 'categories'.) Codes were reviewed and grouped into categories and then sub-themes but underlying meanings were sought in doing so, involving: "*sorting the different codes into potential themes and collating all the relevant coded data extracts within the identified themes*" (Braun and Clark 2006:89). During this process some synonymous codes were detected and merged; some codes were found to have been used in inconsistent ways and were divided. Some codes were found to be sub-codes of others or codes representing a broader category. But the core of this stage was to identify categories and themes in and through the data. It was about investigating relationships between codes, categories and different levels of themes – both the main overarching themes and sub-themes. Themes which seemed interesting and rich were pursued: others were dropped. Prior knowledge of the domain, and evidence and ideas gleaned from the preliminary study, influenced all of this process, most particularly perhaps in the choice of which themes and sub-themes to pursue. Tables presented in the later analysis chapters (Tables 5-2, 6-1, 7-1) show the codes (relevant to the themes pursued) derived from each study and data source. Later tables (Tables 5-3, 6-2, 7-2) show the categories which were derived from them and the resulting sub-themes.

This analysis process was supported by the use of a mind mapping program, *Freemind*, to generate a 'thematic map' which was used to investigate the linkages and hierarchies between codes and emerging themes. Issues which seemed to be emerging led to some slight changes to the data collection instruments, as indicated by the feedback loop in Figure 4-1.

It is suggested that by using QDA software: "*the resultant web of meaning will be certainly more complex and more confident than the manual method would have*

supported, the knowledge far deeper" (Richards and Richards 1994:171).

Certainly ATLAS.ti supports facilities, such as the identification of clustering within codes, which might be more useful with other analytical approaches. However such facilities were not drawn on here: they were not needed, although the facilities to manage code hierarchies and synonyms were useful. Here the software was just used to retrieve relevant quotations and data extracts.

From this stage Braun and Clark's approach was not helpful. For them, findings, themes and so on would emerge from the coding processes alone, in the manner of Grounded Theory (for example, Urquhart 2013).

In parallel with directly working with codes and categories looking for themes, as tentative ideas began to emerge, Actor-Network Theory Analysis Diagrams (AADs) were created. This analytical device is described below (§4.5.1) and, as will be seen in the later analysis chapters (Chapters 5-7), their creation focussed thinking on the actors and their interactions and provided evidence for existing or additional codes, clarifying and elaborating the emerging themes. Applying the lenses of Structure-Agency and Social Practice to both the corpus and the emerging themes provided yet more ideas and understandings. The application of these analytical devices is indicated in the tables of codes in Chapter 5-7 (Tables 5-3, 6-2, 7-2). The application of other existing theories and concepts provided further, deeper insights into the themes identified, as indicated in Figure 4-1. This use of the theories in the conceptual framework was mostly at a slightly higher level than the initial coding and categorisation work. It was looking for meanings and connections within the emerging categories and sub-themes.

On some occasions during the analysis and interpretation it was helpful to appeal to understandings gleaned through professional practice, although not directly evident in the data corpus. This was done with both restraint and caution and is made explicit, both in the data coding tables in Chapter 5-7, in addition to the thesis narrative.

Writing activity was also a significant element in the analysis process: creating text which endeavoured to describe, clarify and explain emerging ideas, leading to further clarification of ideas. This analytical process is evidenced in later

chapters, providing a derivation of, and evidence for, each chapter's theme and sub-themes.

4.4.11 Writing stages

The final research stages involved writing. Writing was very much more than simply documenting research tasks and findings. Writing clarifies your thinking since when writing you are compelled to engage with the logic and implications of the arguments being put forwards. Writing therefore provides an invaluable tool for analysis (Richardson 2000). One of the lessons learned is quite how much writing a qualitative thesis is an active process, rather than just creating and editing an extended series of drafts.

Wolcott distinguishes three forms of writing, of presenting and "*transforming qualitative data*" (Wolcott 1994:3) into useful outputs: description, analysis and interpretation. As he observes, many authors refer to them all as 'analysis' although their intellectual nature can be very different. In Figure 4-1 these are represented as separate stages. However there was substantial movement of activity between them: they were not sequential tasks.

The starting point for writing was description, consisting largely of organising the extracted evidence around the identified themes, each structured by sub-theme. The data comprised very many forms of material, including transcripts, images and rankings, some of which was included in the developing narrative to elaborate the themes and sub-themes. Thus an account was created which included long quotes, similar examples, and material and ideas which were later deleted. "*Everything can be edited later*" (Wolcott 1994:14) and it is much quicker to delete irrelevant material later than to re-locate half-remembered items. A few of the ideas came from personal, experiential knowledge, although these were acknowledged and used with caution.

Having created a bloated, descriptive account, focus moved to introducing more rigour and to writing more for analysis and interpretation. Analytical writing sought to interrogate data, codes and emerging themes, drawing out fresh ideas and new understandings. Care was taken to look for alternative explanations

and counter-evidence, particularly in order to try to avoid insider bias. However the process was not one of seeking universal truths but of capturing and understanding some of the rich variety of the participants' views and influences.

Analysis and interpretation were barely separate stages but activity moved between them, with the balance changing. Initially most writing was descriptive but became more analytical and interpretive, with analysis slightly dominating even in the latter stages (Figure 4-5).

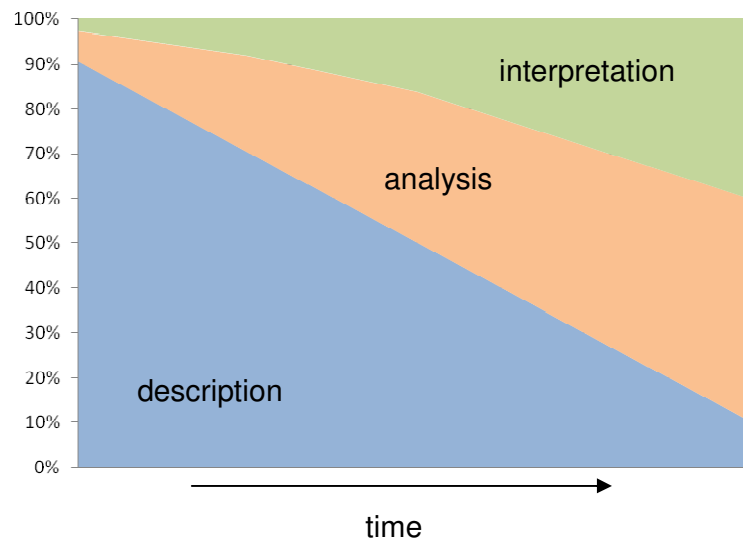


Figure 4-5: The changing balance of writing work

Analysis activities included creating models of interactions, patterns of influences and matrices of behaviours. The writing was made more focussed on issues, relationships and details of interest, a strategy which Wolcott (1994) also considers to be analytical. Ideas and findings were linked to others', pre-existing, larger theories: existing literature was drawn in. Wolcott considers that this task can be interpretation however it does seem rather more analytical. The distinction might lie in scale and import. The main interpretive work was in reflecting on the implications of findings for the diverse range of stakeholders.

In this way themes and findings were generated and the research project completed. The final section in this chapter describes the methods used for the generation and collection of empirical materials of various sorts.

4.5 Data Collection and Other Methods

As has already been mentioned (§4.4.8), the data from all methods were not used in analysis. There were a number of reasons for this, ranging from lack of relevance to the ultimate research questions (for example, the portfolios submitted) to simply the lack of time or necessity (for example, the timeline and 'Day In The Life'). Whilst Appendix B includes all the methods employed, for reasons of space and to assist the reader, only the methods where the resulting data was used are elaborated here.

4.5.1 Analytical Method: ANT Analysis Diagrams (AADs)

ANT considers how a number of actors in a network interact with, and affect, each other (§3.2). As has been mentioned diagramming has not had any significant role in the ANT literature. However the nature of relationships in networks, 'bringing together' actors in pairings or other groupings, seemed to demand some diagrammatic representation. The description of an actor-network

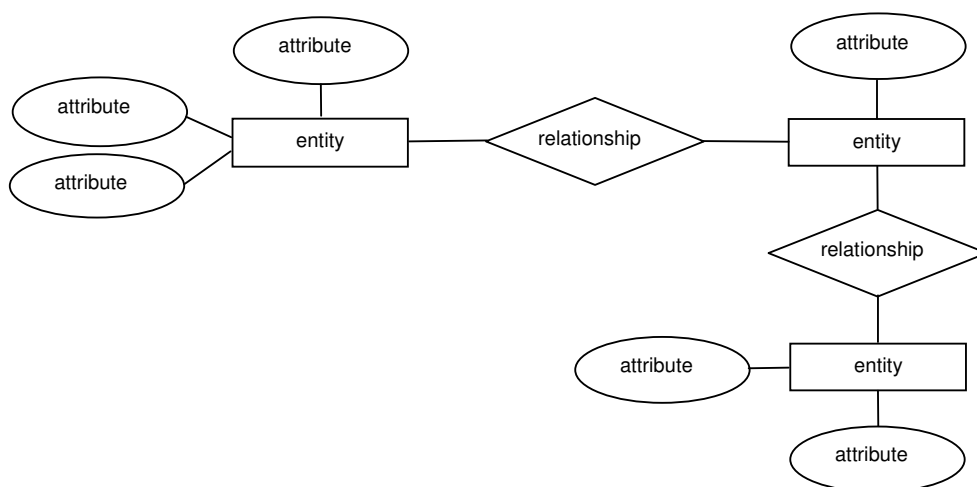


Figure 4-6: A vacuous ERD (or AAD)

is redolent of an entity-relationship, which evoked connections to entity-relationship diagrams (ERDs): a standard database design technique. Developing a variant on ERDs for use with ANT networks proved very useful. There are several styles of ERD diagram but the one which seemed most useful is the earliest, that defined by Chen in 1976 (Elmasri and Navathe 2007), which allows clear representation of the characteristics of entities. A vacuous example is shown in Figure 4-6 depicting three actors (objects, entities), with their associated properties (attributes), and the relationships (associations) between them. This arrangement can be seen as representing a small ANT network.

However it proved useful for AADs to show the types of objects involved, since this character can be important for understanding the processes involved. In the version of ANT adopted here, objects can be one of three types and thus the notation in Figure 4-7 was developed.

Solid lines are used for fluid objects; double lines immutable mobiles, which are fixed and dashed lines for fire, absent-presence objects, which do not always exist and can be seen as being optional. (The semantics given to the double line differs from Chen's ERDs: he used it to indicate optionality.) Object properties can be included as and when useful. Similar notations were developed for relationships, with solid lines for most, reflecting their ability to change; double lines for those which are fixed and dashed lines for relationships which do not always exist and can be seen as being optional.

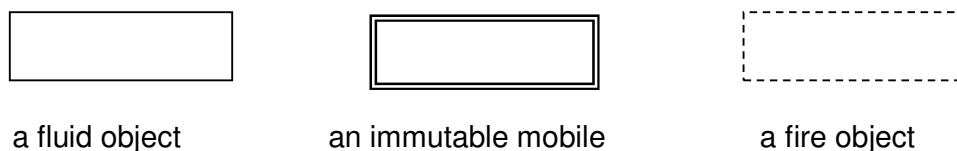


Figure 4-7: ANT object notation

The connecting lines between objects and their relationships can again use the same conventions: double lines to reflect enduring connections; dashed lines if they are not always present and solid lines for most. However since these

meanings can usually be deduced from the objects and their relationships it is seldom necessary to draw them in this way. These lines can take the form of a directed arrow when it is helpful to indicate the direction of influence. Any number of objects can connect to a relationship. From an AAD perspective, there is no reason why they should be pairs.

A number of AADs were created during data analysis. Whilst their contents and significance will be explained when they are presented, it is hoped that the reader will appreciate their general form and nature from this brief introduction. This style of diagramming was invented to assist with analysis, and that is seen as its main *forte*, although it does also have value in supporting explanations. Hence the AADs have been left hand-drawn to emphasise their role as working documents. The process of creating AADs reifies ideas, encouraging the rigorous consideration of each element in a network of interactions, in the process revealing issues and influences which might otherwise pass unnoticed. They were both useful and powerful.

4.5.2 Interviews

One-to-one interviews were the core data collection approach used across all four main studies. Interviews are needed to get at explanations (Porter 1994). Interviews were held in person for participants enrolled at Coventry and by telephone or audio- or video-SkypeTM for the others, according to participant preference. The intention was that all were recorded (although there were a few technical failures which lead to two interviews needing to be 'reconstructed' from contemporaneous notes).

The interviews took somewhat different forms according to the particular context. All were semi-structured and were managed using a schedule. Generally, there was a series of prompts, with extra probes used to expand responses, as necessary (Ryan, Coughlan and Cronin, 2009). Some interviews lasted well over an hour whilst others as little as 15 minutes. Some were very specific in their purpose. For example, there was a conversation with some to discuss the image scrapbooks which had been submitted – to delve deeper into the images chosen, their meaning and rationale. Interviews were held with the longitudinal

participants at key stages. There were interviews with students on the engagement study to explore their interactions and relationship with their course, with a view to determining the nature and background to their apparent disengagement.

The key interview with the longitudinal pupils was the initial one, which elicited their life history. Whilst also exploring social and family issues, this interview was designed to trace back the origin of, and influences on, their interest in computing. In line with advice from McAdams (1995), the participant was asked to see their life as a series of chapters. Those suggested were pre-school, primary school, early secondary school (up to age c.15) and then recent years. This was a useful device, allowing discussion to remain focussed on a life-stage, with reasonable clarity about the rough age at which events occurred.

A selection of interview schedules is provided in Appendix D. All developed through the project, based on previous experience, although no major changes were necessary. The recordings were transcribed for analysis, most by the researcher and others through an agency. Since there were 100 hours of audio recordings, not all were fully transcribed. Some were partially transcribed, focussing on sections emerging as being of particular interest and notes made of the topics covered in the non-transcribed sections.

Transcribed sections were fully transcribed, including non-verbal utterances such as laughter or extended pauses. Accounts were punctuated with care to ensure that the perceived meaning was presented. The transcripts also included a note of who was speaking, timing and numbered 'talk-turns'. Researcher annotations recorded any initial thoughts about the data, particularly observations and ideas which emerged during the transcription process, allowing the researcher to *"remain open to ideas, patterns, new categories or concepts, that may emerge during the process of making data"* (Richards and Richards 1994:149). All transcripts were checked for accuracy and completeness. Particular care in this regard was paid to transcripts which had been transcribed by others.

Some transcripts were shared with participants for member checking to ensure that the correct sense of their contribution was presented. A few of those

participants responded, mostly only where there was an explicit query about meaning or detail. The original intent had been to get all transcripts checked by participants to enhance rigour (Ryan, Coughlan and Cronin 2009). However this was abandoned for a number of reasons. Firstly, and the prime reason, was that most participants were simply not interested in receiving them and for some it seemed to cause irritation: a significant concern when retaining goodwill is important. Secondly, some interviews were not transcribed until some while later and participants could not be expected to recall the detail of the conversation at such distance. The last reason is based on wondering if participants' *post hoc* rationalisations or changes of heart should have primacy over the views they articulated during the interview. Making changes to the interview record seems to almost undermine the interview as an event in time, even if the participant later changed their mind about a response. It may be that an opportunity was missed here. Useful information might have been returned from some if the request had been for them to reflect and, if they wished, supplement or contradict their previous responses. However member checking was abandoned since it was crucial to retain goodwill.

Another significant matter regarding the interviews is that of the relationships between researcher and participant (Whiting 2008). Efforts were made to put participants at their ease. However it is difficult to gain participant trust in a single meeting. Sometimes participants can believe that there is a right answer which is being sought (Woolner *et al.* 2009, College of Education@MSU 2006) and it can lead to participants being guarded in their responses and providing: "*a partial, sanitized view of experience, cleaned up for public discourse*" (Charmaz 2000:525). Also, the researcher is, in part, an insider and as Dwyer and Buckle (2009) warn, participants (in this case especially some on the engagement study at Coventry University), needed to be encouraged to fully elaborate since they understandably would think that the background to their comments was fully known. The reverse was also true that conversations were not always pursued as fully as they might when participants spoke of issues which were recognised. Whilst being alive to these risks and being reflexive in the conduct of the

interviews (Whiting 2008), it is impossible to say that they did not lead to some measure of distortion.

4.5.3 Focus groups and group meetings

All group meetings, both for the focus groups and the in-module study, were video and, separately, audio recorded. A relaxed open atmosphere was encouraged, in part, by providing light refreshments, including home-made cookies (Figure 4-8). Students were encouraged to talk freely within the meeting but told that what was said should not be repeated elsewhere. Care was taken to ensure that all students had a chance to speak and that vocal students did not overly-dominate.



Figure 4-8: A focus group meeting

For the in-module study, group meetings were held weekly for a period of six weeks. There was a theme for each week²⁸ and sessions typically started with an activity which was then discussed.

The focus groups were loosely structured events, although efforts were made to remain roughly 'on topic'. The schedule used is in Appendix D, although it did evolve event-by-event. These focus groups were very productive with conversation flowing easily. Students had plenty to say, even though mostly they were only in their second week of Higher Education. The image collection exercise was particularly productive, leading to much discussion about stereotypes and IT employment. A visually impaired student attended and, to allow them to take part, the other students in turn described the images. This

²⁸ The schedule is at <http://babbage.coventry.ac.uk/csx067/why/inModule.asp>

was a very useful device in that it forced the explicit articulation of the images as they were perceived. It allowed any differences in perception to be brought out and then from that, as at the previous meetings, the implications of the image to be aired. This approach would be adopted in the future.

The focus groups were a very rich source of data. Battles (2010) believes that they are the best approach to use for investigating socio-political issues. They certainly were valuable here, allowing participants to trigger each other, permitting a rich, extended discussion and yet allowing individuals some respite, if desired. Kidd and Parshall (2000) point out that focus groups can be energising and can be of value for studying socially marginalised groups. Whilst not suggesting that any participants were marginalised, some participants were quite quiet and reserved by nature. They may well have been less likely to volunteer for a one-to-one interview.

Kidd and Parshall (2000) also warn of the importance of not taking statements at face value but that it is necessary to exercise judgement. There is a need for care when using most forms of social data. Even in one-to-one interviews participants may want to present a 'front' in some way. For instance, one participant in a focus group did not reveal that he was not a new first year, as everyone would have assumed, but was re-sitting some modules. This was only revealed in a one-to-one conversation later. However this status would affect how some of his comments should be understood. Another participant likes to be the centre of attention. At the focus group he was certainly 'elaborating' somewhat on his IT employment background, as became evident in later discussions. Kidd and Parshall also point out that some authors supplement focus groups with other methods. As the previous comments exemplify, the additional methods used here did provide a vehicle for cross-checking and gaining a richer understanding of issues originally raised in the focus groups.

4.5.4 Image instruments

A number of methods employing a visual element were adopted, such as the tagcloud, to enliven and encourage participation. However the image of

computing emerged early as a theme and the use of visual data collection approaches seemed both relevant and potentially revealing.

Image competition

The HEA STEM competition was described in section §4.4.4. Some entries are reproduced later, as Figures 5-2 and 7-2.

Image tagcloud

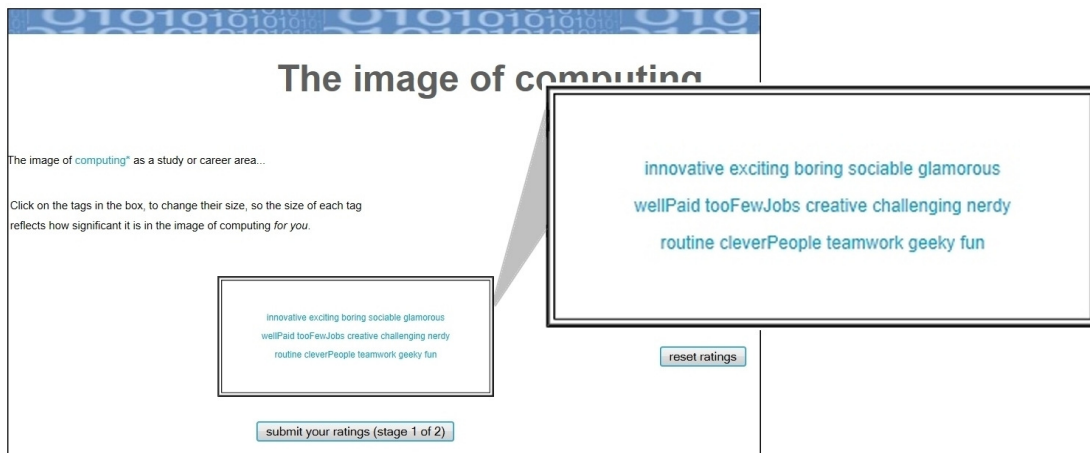


Figure 4-9: Image of computing tagcloud

Interactive webpages were written²⁹ which allowed participants to rate a number of given terms, tags, in their importance to their view of the image of computing. The main page is shown in Figure 4-9. Clicking on any tag increases its size, thus allowing participants to create their own personal tagcloud of priorities. Examples can be seen in Table 5-1. The labels used for the tags were the issues considered by Mitchell (2005) in her study of computing students or identified by her participants. However, some were rephrased such as 'running out of ideas' being recast as 'innovative'. The website also allowed participants to add other terms which were important for them. This instrument was created as an alternative to a questionnaire with Lickert grading, although the resulting

²⁹ Using VBScript, Javascript, CSS, ASP and MS-Access

Wordle™

'Image of computing' scrapbooks

Students were asked to create a shareable, digital scrapbook of images of people: "*using, or working with, computing or IT (ICT) professionally*", with an explanation of their selection. The submitted scrapbooks themselves were of limited value. Some students simply provided screen prints of websites which they used, not fitting the requested material. Scrapbooks were discussed with contributors, leading to some useful discussions. Rose (2007) noted that it is only by interview that you can access the information in, for her, a photograph. The situation here is slightly different since participants were asked to provide explanatory text to support their images. Hence discussions were not always necessary to access the intended meaning.

Although many scrapbook submissions were thin, they seemed to highlight participants' lack of knowledge about the ways computers are used professionally or maybe sometimes they just failed to grasp the nature of the task, despite being given a sample entry.

This activity did not engender real interest. Maybe it was just too burdensome, seeming too much like work. Certainly the creativity seen by Bragg and Buckingham (2008), albeit working mostly with younger pupils, was not evident here. Some of the images submitted feature later (such as Figure 5-8).

4.5.5 How did you decide: pyramid of career influences

Students were asked to use Post-It® notes to create a ranking of the people who helped them with their course choice and the resources and events which they made use of, for example Figure 4-11. Some of the individual Post-Its are reproduced later.

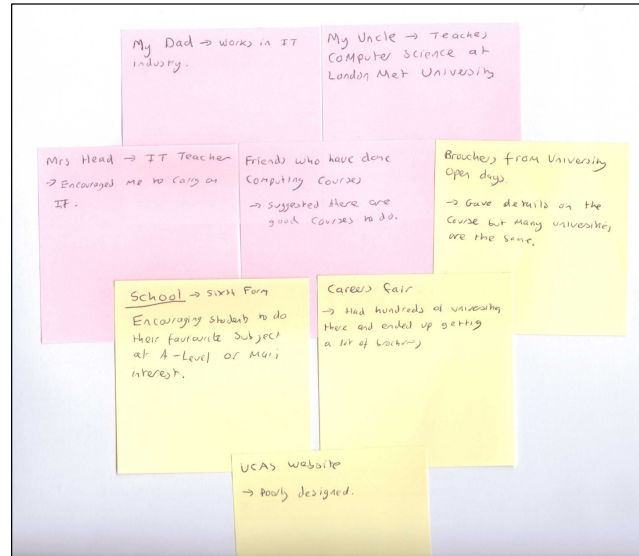


Figure 4-11: An example pyramid of career influences

They were asked to add a comment for each explaining why they had ranked them as they had. Woolner *et al.* (2009) asked participants to rank items in diamond pattern, identifying one clear top preference. Here, participants were advised that the final pattern might resemble a diamond or pyramid (Figure 4-11). Rankings were then discussed with the participant. This exercise seems to have been appreciated by participants and was probably more engaging than an equivalent textual task.

A number of the methods adopted primarily served to enliven or trigger subsequent discussion. The methods used developed reflexively during the project, learning from experiences of the earlier work. Most notably the use of interviews with longitudinal participants became more targetted to try to ensure that they remained supportive and willing to talk at their key decision points. Whilst interviews and focus group discussions were by far the most useful, by virtue of the opportunity to confirm and cross-check understandings, some methods served to replace interviews or to introduce diversity in the interactions. Other methods could have been used but these were chosen for a range of reasons such as their credibility or flexibility. In designing the methods notice

was also taken that these are IT-focussed participants. Therefore, to align with participants' interests, opportunities were sought to make use of online and electronic facilities. The blogs and Facebook group (§4.4.7) were both set up with the hope they would generate data although the blog was never launched and the Facebook group did not generate much interest.

4.6 Conclusions

Having first discussed the philosophy of the research paradigm adopted, this chapter has discussed the methodology and research process employed in this project. It has described the research studies, and the methods used on those studies to collect data. As has been explained, the most useful data was generated from sessions of open discussion: the focus groups and interviews. These permitted the relatively unencumbered exploration of issues with participants, allowing a reasonably full understanding to be gained. Whilst the other methods employed mostly feature rather little in the subsequent analyses and interpretation this is not to suggest that they were of little importance. Some have been used explicitly, some provided elaboration and sometimes they have provided pointers to issues which could be pursued. However, there is little doubt that having a series of regular, hopefully interesting activities kept participants engaged. Some participants were involved in the longitudinal study for up to 18 months: such activities helped to keep them 'locked in'.

Having explored the background and conduct of this project the following chapters move on to look at the findings from the analysis and interpretation of the data corpus. As has been described (§1.2), research commenced guided by some general objectives. As work progressed three main themes emerged, and associated with each an evolving research question. These themes were image, choice and student engagement and each forms the topic of one of the following analysis chapters.

5 : "*People call me a geek*": the image of computing



Table 5-1: A range of tagclouds submitted by participants

5.1 Introduction

The previous chapter described how the research data were generated, analysed and interpreted. As described (§1.2), the whole project was to look at the processes involved in students' choosing of computing courses, with a view to determining if there could be changes or mechanisms which might lead to the more consistent enrolment of appropriate students. This chapter is the first of three which will present those findings, each focussed on one of the emergent themes. Subsequent chapters will look at the themes of course choice and student engagement but this chapter will consider the image of computing and the research question which evolved into:

How do young people perceive the image and nature of computing as a subject and profession? This includes how they relate to computing personally and the stereotypes of 'nerd' and 'geek'.

Whilst this, and the other research questions, will be addressed directly in Chapter 8, this chapter will present the related findings and analysis.

The perceived image of any subject will influence whether a student chooses to apply for it, since their impressions will affect whether they wish to identify with that subject and become part of it. It will be shown that participants often have only weakly developed views of computing as a cognate area, course and profession but they are well aware that outsiders can see it quite negatively. Thus this chapter will consider students' and pupils' views of the image and nature of computing and the IT profession and how they relate to them. Since the stereotype of 'geek' and 'nerd' is often associated with computing, participants' relationships with this are also explored.

The chapter is structured around three sub-themes: qualities of the subject itself, employment issues and the character of the people in computing. It will first consider the subject of computing itself: how students perceive it, its qualities and nature. Then students' perceptions of the character of IT employment, and their expectations of career structures, will be discussed, followed by their perceptions of the workplace environment and IT work culture. Finally, and most particularly, their views of the image of individuals engaged in computing, and

the stereotypes of 'geek' and 'nerd', are investigated. Whilst some implications will be raised, those will be discussed in Chapter 8, along with directly addressing the research question.

This chapter commences with the presentation of two tables which together illuminate the analysis process employed (described earlier, §4.4.10), as related to the chapter's theme of 'image'. Table 5-2 shows which study and data sources contributed to each of this chapter's sub-themes, whilst also identifying the codes created for that data. Then, Table 5-3 indicates how the codes were grouped into categories and fed into each sub-theme. As has been said, this was not a Grounded Theory project and the codes alone did not derive categories and themes. Ideas obtained by reviewing the data through the three analytical lenses (see §3.1) also informed the derivation of most data categories, although the lenses were not equally useful throughout. These ideas are also indicated in Table 5-3.

Sources of data: theme IMAGE			
Sub-theme			
	The nature of computing	Perceptions of IT employment	The image of the individual
Study sources			
Preliminary	confusion with ICT, inconsistent naming, mathematics, not a lot of people know, routine, theoretical	employment opportunities, well paid employment	image, nerds and geeks
Longitudinal	ability, challenging, computing v ICT, creative (productive), exciting, fun, inconsistent naming, innovative, mathematics, problem solving, routine	career knowledge, well paid employment	clever people, geeky, geeks
Focus group	binary (programming in), boredom, confusion with ICT, creative (imaginative), creative (productive), emotional feedback (positive), exciting, exclusivity of the subject, how things work, image misleading, image of computing, immersion, innovative, logical, mathematics, nature of computing, not a lot of people know, not routine, patterns, perception of IT, persistence, pleasure, practical bent, problem solving, programming (ability), programming aptitude, Python's easy, sense of achievement, technical, tedious work, theoretical	age profile, career - salaries, career knowledge, career options, employers requirements, employment opportunities, flexibility (at work), gender balance, work culture, work from home, work-focussed, working environment (positive/negative), working hours	image, intelligent, 'IT Crowd', narrow-minded, nerds and geeks, social interaction, stereotype, unhealthy, unsociable
In-module	challenging, creative (imaginative), exciting, fun, image of computing, imaginative, innovative, mathematics, programming (ability)	flexibility (at work), well paid employment, work culture, working hours	identity, image, introvert, nerds and geeks
Engagement	boredom, computing v ICT, creative (productive), mathematics, programming (ability)	career knowledge	nerds and geeks
Image participants	'best moments', beauty, patterns, programming (ability)	ordinary person	ordinary person

Data sources			
1:1 interview	ability, boredom, challenging, computing v ICT, creative (imaginative), creative (productive), emotional feedback (positive), exciting, image of computing, imaginative, inconsistent naming, mathematics, not a lot of people know, not routine, patterns, persistence, pleasure, practical bent, problem solving, programming (ability), Python's easy, routine, sense of achievement, theoretical	career knowledge, career options, employment opportunities, flexibility (at work), work culture, working hours	geeks, identity, image, introvert, nerds and geeks, stereotype
Group meeting	binary (programming in), confusion with ICT, creative (imaginative), creative (productive), emotional feedback (positive), exciting, exclusivity of the subject, how things work, image misleading, image of computing, immersion, innovative, logical, mathematics, nature of computing, not a lot of people know, perception of IT, persistence, pleasure, practical bent, problem solving, programming aptitude, sense of achievement, technical, tedious work	age profile, career- salaries, employers requirements, employment opportunities, gender balance, work culture, work from home, work-focussed, working environment (positive/negative), working hours	image, intelligent, 'IT Crowd', narrow-minded, nerds and geeks, social interaction, stereotype, unhealthy, unsociable
Image competition	'best moments', beauty, patterns, programming (ability)	ordinary person	ordinary person
Image tagcloud	challenging, creative, exciting, fun, innovative, routine	well paid employment	clever people, geeky, social interaction
Wordle™	challenging, creative, imaginative, innovative	working hours	social interaction
Image collection (used in focus groups)	binary (programming in), emotional feedback (positive), exciting, exclusivity of the subject, how things work, image of computing, immersion, innovative, not a lot of people know, tedious work	employment opportunities, work culture, work-focussed	nerds and geeks
'Images of computing' scrapbook		working hours	
How did you decide: Pyramid of career influences			

Table 5-2: Sources of data: theme IMAGE³⁰³⁰ Not all Data Sources applied to this theme

The derivation of theme and sub-themes: IMAGE				
Sub-theme	Category	Codes from text sources and ideas from lenses and other sources	Example quotations and examples of sources	Category informed by analytical lenses
1. Nature of computing	It is not understood	computing v ICT, confusion with ICT, image misleading, image of computing, inconsistent naming, nature of computing, not a lot of people know, perception of IT	"people immediately assume its ICT"; "it must be really difficult because you're dealing with science"; "people find it more amazing than it is"	S&A TSP
		much IT activity is private and hard to describe to outsiders	Structure-Agency lens	
		personal understanding (as a form of cultural capital)	Theory of Social Practice lens	
	Practical or theory	practical bent, technical, theoretical	"There wasn't that much practical: it was just more theory"; "very technical minded"; "once I got into the practical it was fun"	
		how things work, problem solving	"I like problem solving which a lot of what I'm doing is that"; "to know how things fully work you have to know about all the programs and stuff like that"	
	Patterned and logical	logical, patterns	"to work with a computer you have to be logical"; competition image (Imogen see Figure 5-2)	
		mathematics	"we use a lot of maths and use a lot of logic work"	
	Challenge, difficult, exciting, boring	boredom, persistence, routine, tedious work	"obviously it's a bit tedious at times"; "a lot of people I know are very interested but it's just the tediousness of it"	ANT S&A TSP
		ability, 'best moments', challenging, exclusivity of the subject, immersion	"I thought I was going to do better in it"; "if something went wrong I'd try to fix them"; "you do stuff no-one else knows about"; "because I got so stuck into it... I'd done it in an hour"; tagcloud (Emma, Rustyrose see Table 5-1); competition image (Les see Figure 7-2)	
			ANT analysis	
		exciting, innovative, sense of achievement	"pretty exciting and fun"; "fascinated with how it worked and what you could do with it"; "it was such a sensational feeling"; tagcloud (Jay see Table 5-1)	
			ANT analysis	
		some pupils/students are very deeply embedded in computing	Structure-Agency lens	
		beauty, emotional feedback (positive), fun, pleasure	"I did have that pleasure of getting things to work"; competition image (Imogen see Figure 5-2)	

		binary (programming in), programming (ability), programming aptitude, Python's easy	"have a natural knack for coding"; "think programming is some incredibly impossible mathematical thing"; "it would be a very silly degree for him to choose if he had no interest in programming"; "the programming... I do enjoy it but its also daunting"; "well Python's easy"	
		presentation of self as expert as an act of ridicule and domination	Theory of Social Practice lens	
	Is it creative	creative, creative (imaginative), imaginative, not routine	"I think you can also be an artist and that's where creativity really comes into play"; "the creativity gave you freedom"; Wordle (Michael see Figure 5-4)	ANT
		creative (productive)	"you've made it and it's on the screen"; "you've created things"	

2. Perceptions of IT employment	Employment structures	career knowledge, career options, employment opportunities	"so many different angles you can go down"	ANT S&A
		employers requirements	"some companies insist on a degree"; "you can do well with just experience instead of a degree"	
			ANT analysis	
		well paid employment, career - salaries	"I think everyone seems to [know]... that you'll get a lot of money"; tagcloud (Alex, Emma, Rustyrose see Table 5-1)	
		age profile	"the people who dominate are still the older people"	
		gender balance	"she didn't like the idea of hanging around with too many men"	
		attracted by perception of employment structures, perception of number of vacancies, prominence of employers' diverse requirements, perception of importance of a degree in employer recruitment	Structure-Agency lens	
	Workplace and work culture	work-focussed, work culture, working environment (positive/negative)	"they have to do that to make their employees feel a bit more chilled out"; "life appears to be quite work-based"; "do long hours and not speak to people"; "to introduce more social life in"; "they just drink coffee all day"; "employees are just a cog in a wheel... spinning around"; "you're with people who don't communicate all day"	ANT S&A TSP
		flexibility (at work), work from home, working hours	"choose own working hours"; "you have to organise your own work"; "working from home indicates that you're successful"; Victoria's scrapbook image see Figure 5-8	
		flexible working arrangements give agency to work in the most rewarding ways	Structure-Agency lens	

		local norms affect one's ability to perform and one's enjoyment of the job	Theory of Social Practice lens	
3. The image of the individual	Geek and nerd	geeks, geeky, identity, image, 'IT Crowd', nerds and geeks, stereotype	"you can do something that they can't"; "it can be used to express respect"; "I've had a couple of people call me a geek"; "incapable of seeing outside their own focus"; "an obsessive-compulsion... to find out how [things] work"; tagcloud (Emma see Table 5-1)	ANT S&A TSP
			ANT analysis	
		weak social capital but strong human capital, TV image of IT suggests social interaction is unimportant	Theory of Social Practice lens	
		deterrence effect of stereotype, these terms are given a range of personal significations	Structure-Agency lens	
	Other characteristics	ordinary person	Raith's image submission	TSP
		clever people, intelligent	tagcloud (Rustyrose, Sunny see Table 5-1)	
		unhealthy	"they're not the healthiest of people"	
		social interaction, introvert, narrow-minded, unsociable	"you use teamwork, socialisation [i.e. social skills] and stuff like that"; "when you work with computers I don't think you really need anybody else"; tagcloud (Dave); Wordle (Jay)	
		knowledge obtained through personal contacts (social capital)	Theory of Social Practice lens	

Table 5-3: The derivation of theme and sub-themes: IMAGE

5.2 The Subject Itself and its Qualities

From an ANT perspective there are many associations which can exist between the two actors: a 'student' (of computing) and 'computing' (as a subject and activity). Deriving an AAD (§4.5.1), provided a means of focussing on these relationships. A particular student might express their relationship with computing as being 'creative'. But they might have others too, such as 'challenging' or 'exciting' or 'innovative' (see Figure 5-1) and any particular student could have any combination of such associations with computing. The stability and universality of these will be considered shortly (§5.2.6) but first participants' views of computing more broadly will be considered. This will address: the restricted understanding of computing's content, its practical nature, patterned logicity, the emotional responses it can provoke and its creativity.

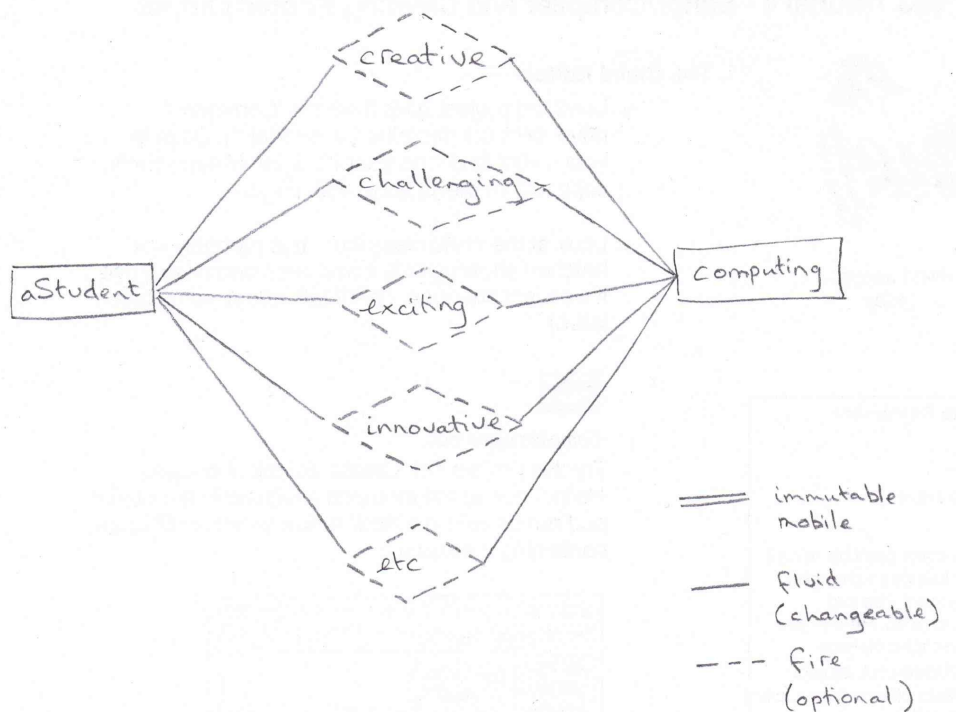


Figure 5-1: AAD of associations between student and computing

5.2.1 It is not understood

Many participants had experiences which suggested to them that there is a general lack of understanding of the nature of Computer Science. At a focus group, Michael commented:

"I think not a lot of people know what CS does... They look at it and it's like: 'Computer [Science] is not a science. Chemistry, biology and physics: that's science'. And they move on" (Michael-1#713)³¹.

At a different meeting, Martin similarly:

"I've seen it go both ways actually. I've said I'm doing computer science and people immediately assume it's ICT and thought it was really easy. [...] And then I've seen people say: 'Oh that must be really difficult because you're dealing with science', and it's not really that either... We're not really talking about people who can come up and draw a theory" (Martin-1#124).

Both these students identify a widespread lack of understanding of the nature of CS, which supports reports (for example, Hewner 2011, Mitchell 2005, Royal Society 2012) of a lack of understanding of computing amongst school pupils, some new university computing students and school teachers. The conflation between CS and ICT which Martin mentioned is explored later (§6.4.1). Here we have personal accounts from enthusiastic '*cognoscenti*', of encounters with that lack of understanding, although they personally had acquired the necessary cultural capital. The social structures which can lead to youngsters acquiring it are explored later (§6.4). The limited formal research in this area has focussed on young people, since it is usually motivated by concerns about the poor recruitment of computing students. However, as has been discussed, it is recognised that this lack of understanding is widespread (for example, Cutts *et al.* 2007) (§1.5) and that there would be benefit in improving the subject's public image (for example, CPHC 2006) (§2.6). This is discussed further, later (Chapter 8), and thereafter the implications action for various stakeholders in Chapter 9.

5.2.2 It is all practical, or is there theory?

Justin emphasised the practical, experiential-learning side of computing.

³¹ *i.e.* Michael, engagement number 1, talk-turn number 713

"When it comes to computing, it's something that is very practical and hands-on. And unless you've done it yourself, like researched it and been taught in a very specific way, you can't learn computing. [...] But the way you learn computing is a lot different: [it's practical]" (Justin-1#141).

His point is that it is important to engage actively and practically to learn computing. He made no reference to any theory, which was typical of participants generally.

"I don't exactly see the computing industry as something that is really academic such as English, maths and science. Because with those you have to actually do a lot of thinking; go out and research; write essays. [...] But in computing I see it as some sort black magic, dark art. Not because I think it is because I'm doing it. But that's how other people see it. If I went up to someone and said, 'oh I made a website' or, 'I coded a website', in their heads they wouldn't understand. Because to someone in the computing industry when... if we do something simple we know it's simple but to someone else it's really complicated" (Innocent-1#108).

This comment of Innocent's will be referred to again later (§5.2.4). However here he is saying that he thinks computing lacks theory and is purely based on skill and technical knowledge, although he did not express it in quite those terms. It is also evident here that Innocent sees himself as being part of computing, an insider, saying: *"if we do something"*. He seems proud to be 'inside' a group of specialists. That he seems to be rather naïve does not detract from his desire to identify with the community. Justin, similarly, sees his decision to study computing as a choice to join a select group.

"There's an exclusivity between, I mean, amongst people in the computing industry because it's like, you do stuff that no-one else knows about" (Justin-1#139).

Omar also focussed on the practical nature of computing, that it is about: *"solving problems and finding that people are using technology to solve that problem"* (Omar-2#90), although later he did refer to theory being dull (§7.2.1).

However overall there is little evidence that these participants are aware of the theoretical underpinnings of computing. This aligns with Lovegrove and Round's (2005) findings that people tend to see computing as a skill rather than a subject. This could lead one to infer that students on these courses are presented with very little of theory, as reported by Boyle, Carter and Clark (2002) although the

theory they refer to is the abstract mathematical underpinnings of computing, such as formal proofs, only taught on those CS courses which are presented as 'hard' science (Lovegrove and Round 2005) and, as the preliminary study found, some of these have limited practical content (§4.4.4). (The implications of this are discussed in Chapter 9.) It is difficult to imagine any HE computing course which does not teach some theoretical material of a 'lighter' nature, as suits the focus of their programme, such as Boolean logic or database normalisation. This could make participants' lack of reference to such background material seem curious. However, most of the data from participants enrolled as students were collected very early in their course. Discussions at a later stage are more likely to have touched on theory. More significantly perhaps, discussions were related to the 'image of computing' and whilst participants clearly see the subject as being practical, it is not clear what these students would have said if asked explicitly about theory.

5.2.3 It is patterned and logical

For Martin the ability to do things, to have current technical skills and knowledge, is the core of what computing is about. He did allude to enduring concepts though when describing people in computing.

"We're talking about people who can look at something and say: "this is a 'while' loop" because it is" (Martin-1#126).

Martin is talking here about the specialist skill of being able to recognise patterns in problems and their underlying logic: the technical work at the core of programming.

Imogen's contribution to the image research study also alluded to patterns (Figure 5-2). Her image shows the semi-organised pattern of a leafless, deciduous tree, partially revealed through a triangular arrangement of circular portholes. Contributors were asked for images which reflect the essence or excitement of their subject and whilst explanations were not requested with submissions, sometimes one was provided. Imogen seems to see it as being a meld of highly organised patterning with other less organised elements. She referred to the filter as a 'mask', something which obscures the image behind,

giving brief opportunities to see what is there. It could well be a representation of the difficulty of seeing the shape and the underlying logic of a computer system. That would be an apposite metaphor.

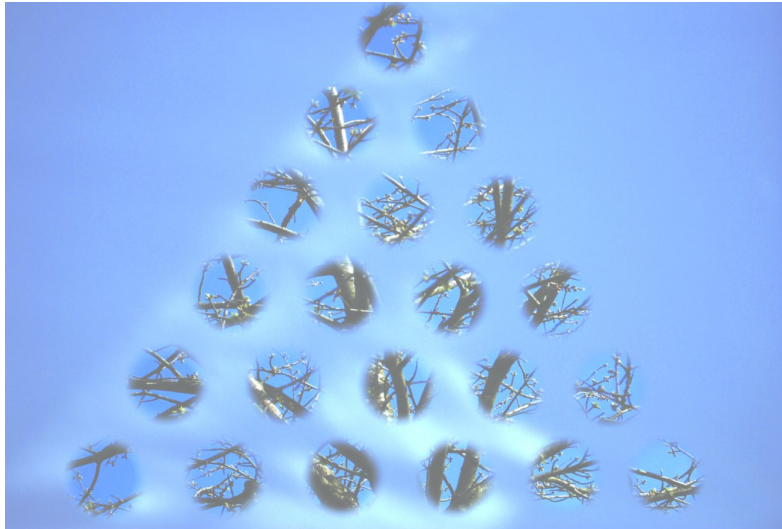


Figure 5-2: HEA STEM image competition entry by Imogen Scott³²

The logical nature of computing was raised several times. Logic is so deeply embedded in computing activity that it is to be expected that all participants would see it as a core quality. John had discussed the nature of computing jobs with his uncle (who works in software development).

"He said: 'we use a lot of maths, and use a lot of logic work, teamwork, socialisation and stuff like that.' I thought: 'well that's the sort of field I'd like to go into' " (John-1#54).

For John, the logical, mathematical basis of computing was a positive appeal.

Omar and Michael would probably agree:

Omar: *"Computers is [sic] all about [logical thinking]. It's kind of like mathematically organised things. It's very logical with steps and sequences and..."*

Michael: *"People who work with computers long-enough you learn to think like one"* (Omar-1#473).

³² Imogen Scott from Dundee. She requested her contribution be attributed.

Thus for some participants the appeal of computing is its patterned and logical nature.

5.2.4 A challenge or too difficult: exciting or boring?

Many participants consider computing to be challenging. The tagclouds (§4.5.4) submitted by Rustyrose and Jay (see Table 5-1b and Table 5-1e) show that they view computing as being challenging and exciting. This combination suggests that they see computing as having a level of difficulty, but that they enjoy rising to the challenge it poses. Excitement can be a result of working with new hardware and may, through their early exposure at home, have started when they were young.

"When I was young there wasn't that much around. When you get like a PC that first comes out it was exciting because you'd never seen one before" (Carl-1#262).

And:

"Because when you're that young things like amaze you a lot more but it sort of carried on because it keeps advancing" (Chris-1#19).

For others, the excitement comes from the sense of achievement of cracking a challenge, rather than the particular technology used. For example, Martin described how he enjoyed the rather advanced challenge of getting two pre-existing programs to interact, by writing scripts to run within the operating system and John recounted that: *"I did have that pleasure of getting things to work"* (John-2#182). This supports findings (discussed earlier, §2.6.1) that pupils studying A-level Computing reported a 'thrill factor' (Lovegrove and Round 2005) but contradicts Shadbolt (2007) who reported that school IT and computing are uninspiring and 'lack excitement'. Whilst the excitement identified in the current research was not usually from school lessons sometimes it was: from either Computing (for example, Dave and Rustyrose) or ICT (for example, Alex and Emma) classes. However, the experience of computing in school is known to be very variable (Royal Society 2012).

In response to being shown a cartoon (Figure 5-3) of a programmer writing code directly in 'computer-speak', in binary 0's and 1's, Omar commented:

"I think that's the perception people have [of] doing programming [...] They think that programming is some incredibly impossible mathematical thing that only like Einstein could do or something: that Bill Gates³³ he had 101010's... And they think there's no way I can understand it. But it's not, I don't think. Perhaps [for] some people [it is]" (Omar-1#600).

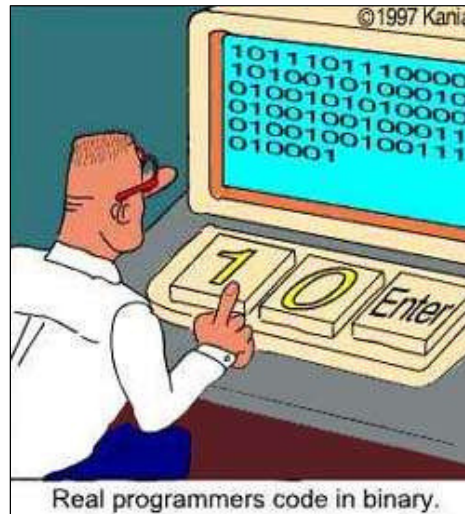


Figure 5-3: 'Real Programmers'

Omar was expressing the view that some people think programming is impossibly difficult but, in his view, it is not and most people would be capable of doing it. He is making the point that the use of compilers makes programming much easier and more accessible than the cartoon suggests. Innocent's comment above (§5.2.2), referring to computing as appearing to outsiders to be 'black magic', makes the same point. Programming can seem opaque and impenetrable. It is not clear that Innocent's choice of metaphor is entirely his own though since the Coventry University annual showcase of students' work is called 'New Wizards'.

Michael pointed out that it is not just 'outsiders' who view programming as very difficult but that some computing students do too.

"You get people on our course [Creative Computing] though who look at the code and go: "oh my god it's incr... it's crazy". So they automatically assume it's complicated. But if you read it: "draw a line". That's pretty much what it says!" (Michael-1#619).

³³ Co-founder and non-executive Chairman of Microsoft Corporation

Here Michael was seeing himself as being more expert, commenting on others on his course, who are finding things hard. Michael sees himself as part of the computing community, which is understandable, not least since he has a part-time job in the area. However, in words but particularly in tone, he was distancing himself from some of his peers and 'othering' them (Collins 1986), regarding them as separate, somehow outside the community. His rather disparaging comment was in a meeting including several other students who may have felt undermined, but in order to emphasise his expertise, Michael was happy to present himself as perhaps rather arrogant. Michael's mental act of othering less-knowledgeable or less-confident students was one of domination. His comment was clear in its ridicule. He was seeing such students not just as less-knowledgeable but far removed from the standard he would expect, questioning their right to be there.

Michael is also highlighting an expectation of difficulty which, for some students, forms a very significant barrier in starting to grapple with programming for the first time. Programming is a threshold concept in computing (Flanagan and Smith 2008) and students need self-confidence and persistence in tackling it (§3.6). John, when talking about his experience of the same programming module, referred to program code as: *"the gibberish that is to my eyes gibberish"* (John-2#488), expressing a similar view to Michael but from the perspective of first-hand experience. Such an extreme expression is surprising from John. Although he had had no personal experience of Python, the programming language he was trying to master, he had learned some VisualBasic during his BTEC in Software Development.

At a different focus group, Chris said he felt that computing is hard: *"it's not an easy route I wouldn't say"* (Chris-1#209). Martin commented that programming is easy if you have done it for years but he also recalled that programming is much more than the syntax which is so problematic for novices.

Innocent believes that many people see programming as being impossibly difficult.

"I just [...] see people have the sort of perception in their head like somehow it's so complicated and they can never understand it. But they actually can if they actually took the effort. So that's why I think that lots of people could do it" (Innocent-1#718).

Justin expressed a similar view but recognised that many people may simply find it boring and tedious.

"People seem to think it's too difficult. I think a lot of people [would] enjoy it but just think it's too difficult. Not 'difficult' as in they can't learn it but 'difficult' as in boring-difficult [...] it's just the tediousness of it" (Justin-1#705).

Some participants recognise elements as being 'routine' or 'tedious'. Alex, in his tagcloud (Table 5-1a), ranked 'routine' quite significantly. Interestingly, he ultimately decided not to pursue computing at university but to study mathematics instead, as being of more interest. Michael recognised a routine element in writing new software but, for him:

"To a point it is [...] routine but if I wasn't seeing something creative and imaginative: if I wasn't getting to use that part of my brain as well I wouldn't do it" (Michael-7#15).

These students acknowledge that some people, even some students on computing courses, imagine programming to be impossibly hard. Programming is a threshold concept which does need to be conquered for a student to be successful on a core technical computing course (see §2.4.1). This does highlight the importance of new programmers being carefully introduced to the subject, in order to develop their self-efficacy (as discussed earlier §3.5.1). The significance and role of programming is explored further, later (§6.5.2 and §7.3.1). These particular participants were all enrolled computing students and, whilst they hold a range of views, it is unsurprising that they mostly see computing as exciting and challenging. Sometimes they are also aware that there can be routine and tedious aspects although none of these participants identified with computing as being boring. Of course that is not surprising: these were all enthusiasts.

5.2.5 Is it creative?

Research has reported that school pupils see computing as being 'uncreative' (CPHC 2006, Lovegrove and Round 2005) (§2.6.1). However contrary to that, some students in this study reported that they find computing to be both creative and imaginative. 'Creative' and 'innovative' were the main attributes identified with by Sunny in his tagcloud (Table 5-1d). Sunny has yet to apply for university but he is attracted to the physical, hardware aspects of computing. It is designing and creating novel devices which appeals to him and he might opt for computing engineering instead.



Figure 5-4: Michael's Wordle



Figure 5-5: Victoria's Wordle

Several students agreed they thought computing was creative. In the Wordle activity (§4.5.4), Michael indicated that 'imaginative', 'creative' and 'innovative' dominate his views (Figure 5-4). Since he is on a Creative Computing course this would hardly seem noteworthy. However Michael may not be typical of students on that course. He applied for Computing but was not offered a place there. Thus, his inclination was towards Computing and yet these creative attributes are very important for him. Victoria and Avtar are both Computer Science students and they also agreed that computing was a creative subject.

Interviewer: *"When you think about people who work in computing how would you characterise them? What are they like? [...]"*

Avtar: *"Very creative I'd say"* (Avtar-1#115).

Victoria's Wordle (Figure 5-5) portrays a range of attributes: 'creative', 'innovative' and 'challenging' being amongst them. Arthur, a student on the Computing course, also spoke of the positive feedback which can be derived from the creativity of computing, in his case through programming.

"Once you've written code, done the run through and you start your program and [...] look at what you've made yourself. It's not physical: you can't hold it, but you've made it and it's on the screen and it's quite good [...] Well, that part of it appeals to me [...] Making something out of nothing" (Arthur-1#47).

However Arthur's pleasure comes from production rather than innovation and imagination. It seems likely that these two meanings of the term 'creativity' cause confusion and when students respond to questions about it, they may not always be answering in relation to innovation. Nonetheless many computing students clearly do welcome the opportunity to be imaginative, which is explored further later (Chapter 7).

5.2.6 So, how do they relate to computing?

There are a number of features which might attract students to computing but a few applicants seem to not have particularly strong opinions. Most participants expanded tagcloud terms through a significant portion of the 10 available font sizes, thereby expressing strongly held views. However Rebel (Table 5-1c) only expanded her selected terms by the smallest possible amount. Rebel was yet to apply to university and, although in conversation she seemed keen and clear that she wants to study computing, her views were likely to be at an early stage of formation.

It is to be expected that students have differing views of the subject, and are attracted for differing reasons. As has been described, some are attracted by the sense of practical achievement or creativity; some by the logical basis of the subject and some by the thrill of conquering a challenge. They recognise that outsiders can see computing, perhaps meaning particularly programming, as boring, tedious or very difficult. Studies looking at the low uptake of women in computing sometimes focus on the aggressive nature of some terminology: abort, kill, reboot, execute, violation (Grundy and Grundy 1996). Although such

terminology is less visible externally than it was decades ago, it does, in part, inform the external image and some people will find it alienating. Participants here did not refer to this sort of alienation but they were mostly male and had presumably overcome any barrier of this type which they may have encountered.

Participants' views (for example John, Matthew, Omar, Victoria) confirm that computing suffers from an image problem (Computing 2007). However, whilst these participants do not personally see computing as "*'determinist', passionless and uncreative... mundane, unimportant or irrelevant'*" (Lovegrove and Round 2005:7) they would generally agree that these can be outsiders' views. In a conference to identify the '*Grand Challenges*' facing the profession, it was recognised that there is a need to change the public image to one offering exciting challenges (McGettrick *et al.* 2005).

There can be tensions amongst the attributes identified by participants. For example, the logical working required for a computing task, and the nature of the task itself, can limit the degree of creativity available. For some, the sense of being able to do something tricky and distinctive, which identifies them as clever or skilful, is of appeal. This will be discussed later (§5.5), whilst considering stereotypes.

It is clear that several of these participants (for example, Innocent, Martin and Michael) already see themselves as 'computer scientists' even though they were typically just embarking on their degree studies. By contrast, they see some of their less experienced peers struggling and, whilst recognising their difficulty, are not always very sympathetic. Indeed in some cases they seem to be treating them as outsiders, 'othering' them because of their mental barriers or the difficulties they encounter.

When using the ANT lens (§5.2) the question of the stability and universality of the associations between a student and the subject of computing arose. The evidence suggests that no particular relationship is always present, meaning that they all have the character of 'fire': they may or may not be present. The enduring nature of these associations, where they are present, is interesting. Students, such as Chris, who report they find computing to be 'exciting', often

reported that they formed this view many years ago. Students, like Carl, who are attracted by the 'innovation' of computing talked about having developed this fascination at an early age. These positive enduring associations with computing can lead students to want to pursue a degree in the area. Whether they feel the same through their studies is likely, of course, to depend upon their experiences, which are explored in Chapter 7. Conversely, it is reasonable to wonder, when young people develop a negative association with computing, such as 'boring', if this can also be stable and enduring. The potentially enduring nature of such relationships suggests the importance of positive early experiences.

Having explored how participants see computing as a subject, in order to continue exploration of their image of the subject as a potential career, it is now appropriate to move on to explore their view of computing jobs and the IT profession.

5.3 Employment Structures

Using the lens of ANT to consider participants' attitudes to, and perceptions of, the IT workplace and employment revealed a number of issues, which are presented as an AAD (Figure 5-6). These will be discussed, firstly considering issues related to employment structures followed by those related to the workplace and its culture.

Overall participants' knowledge of jobs in IT was rather limited, however some recognised that computing encompasses a wide range of issues and can therefore lead to a wide range of employment opportunities.

"[Computing is] advertised that it's more about maths and technology, building something super-advanced, like a robot that can talk or walk or something like that [...] Whereas, although computing does do all of that [...] there are other issues that deal mainly with people and their issues"
(Omar-2#216).

Carl, comparing images of a Games Testing Laboratory and a robotic engineering laboratory, commented:

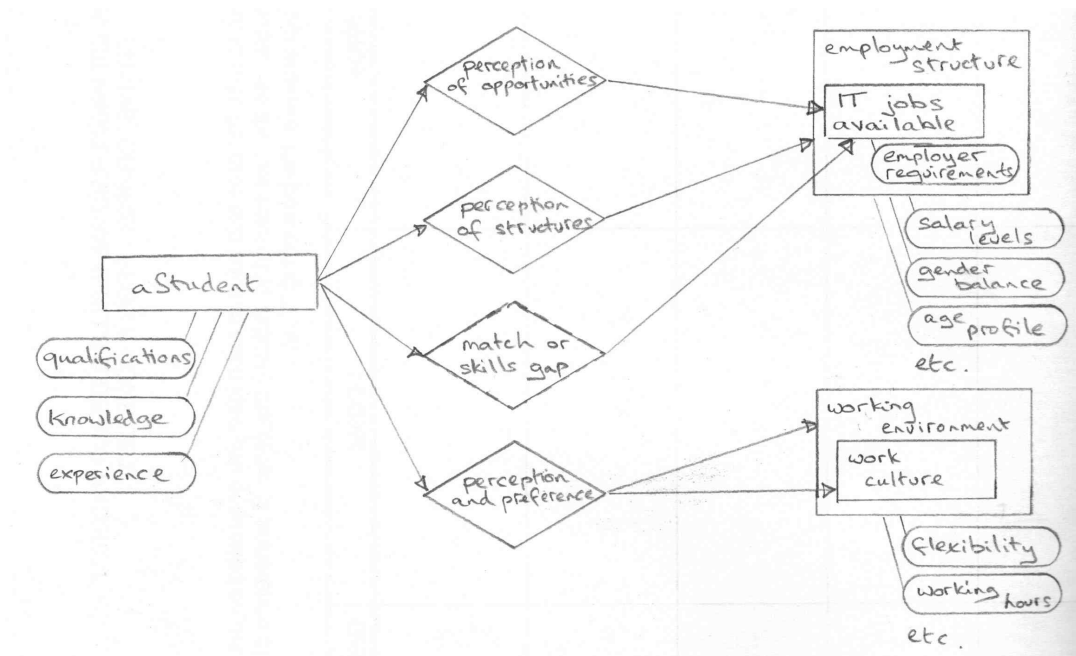


Figure 5-6: AAD of the workplace

"If you're working as a robot engineer for NASA it's going to be pretty exciting and fun and it's going to be quite challenging as well. Sitting there and testing games is not" (Carl-1#470).

Others are also aware that jobs are not always glamorous.

"I know someone [...] and she resets passwords most of the time. It's quite annoying when you have a first class degree and you get such a job. You expect something more" (Farouk-1#425).

Farouk was expecting that his friend would be doing something with greater challenge, better fitting her education.

Triggered by a picture of Google's offices (Figure 5-7):

"You probably think you know computing as the last image you saw [the network administrator]. But, as at Google, there's a whole different type of computing – a whole... they're more creative in a way, [...] a completely different way of thinking about using computers" (Omar-1#404).

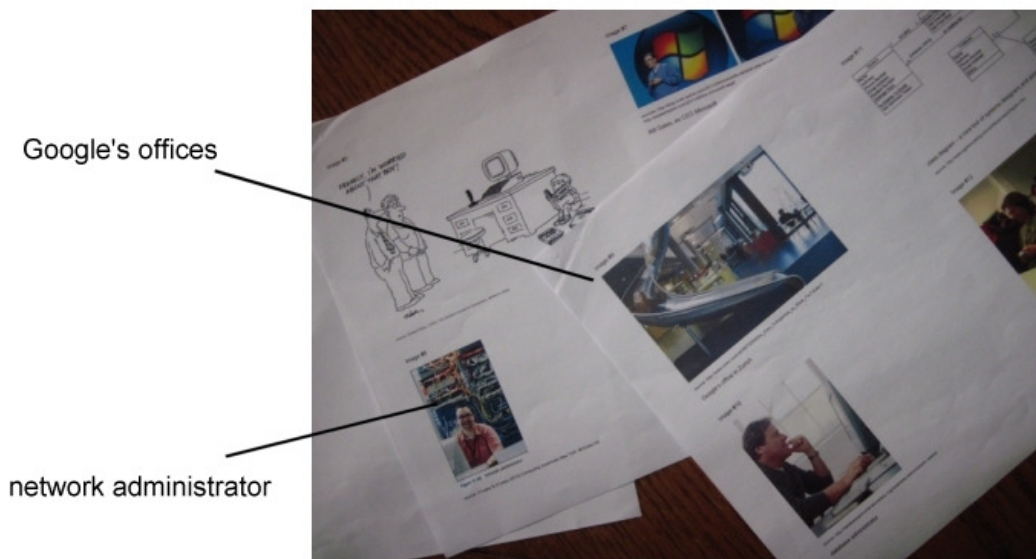


Figure 5-7: Part of the image collection

Omar realises that there is a range of types of potential employment in computing. This fits with the recognition that: *"students are attracted by a varied job and good salary and range of jobs/industries that use IT"* (McGlinchey 2012:37).

Students are understandably concerned that their degree should give them skills which make them employable. Michael was aware that employers look for both a degree and relevant experience.

"Three years in Uni to get a degree in CS or you could spend three years at the bottom in a company and at the end of it you'd still have the same job but an employer might go: 'well they've got three years' experience'. Now, I know some companies insist on degrees but when it comes to computing because, I mean [...] they see experience as better" (Michael-1#663).

Similarly, at a different meeting:

"You just have to be good at what you do. It's one of those industries [...] you don't have to have a degree. [...] It's just what you do: a portfolio is more important than a degree itself" (Justin-1#258).

These participants realise that some employers are looking for skills and experience, perhaps as much as a degree, which must be disconcerting for students who, understandably, have entered HE thinking that a degree is the passport to a good IT job. As will be explored later (§6.5.3 and Chapter 9), aside from the issue of experience, there is a tension between the structure of computing degrees and the tightly-prescribed requirements in some of the industry, leading to students having limited agency and restricted opportunities in the graduate-level computing jobs for which they can apply.

The prospect of well-paid employment is clearly an attraction for many. For Alex this was the dominant factor in his image of computing (from those offered in the tagclouds) (Table 5-1 a). Farouk also believed well-paid jobs are available.

"This Cisco and networking and stuff, as everyone they say, you get good money with Cisco" (Farouk-1#294).

Carl was also aware that IT has a reputation for being well paid.

"It doesn't matter what you're doing if you're an analyst, a programmer, a technician or what, I think everyone seems to have this thing, outside of knowing anything about it, that you'll get a lot of money" (Carl-1#316).

This reputation seems to be widely known amongst participants, although one (Joey) did say that he had no awareness of computing salary levels. Whilst not necessarily a contradiction, as has been mentioned (§2.6.2), Mitchell (2005) found that pupils thought that other professions were better paid.

Another employment structure which creates a problematic image for young people, is its age profile.

Omar: *"At the start of my course they're saying: 'no, in computing not all people are men who are bald, who wear glasses, who have no social life'. They even said that at the start of the year. Not all people in computing are like [that]."*

Michael: *"All our lecturers are [like that]! [general laughter]" (Omar-1#368).*

Whilst this was a light-hearted exchange, some participants were very clear that they think the profession is full of older people.

"The people who dominate [employment] are still the older people. [Employers] see experience as better" (Michael-1#663).

They interpret advertisements for jobs which require experience as implying that older employees are preferred.

"Most employers would do with experience over [youth]" (Michael-1#667).

Of course, even if participants do think computing is dominated by an older workforce they are almost certainly aware of some very young, hyper-successful, IT entrepreneurs, such as Mark Zuckerberg, the creator of Facebook, who was a dollar billionaire by age 23.

It is curious that students should see IT in this way especially since it is likely that when they refer to 'older' they are thinking of over, say 30. However, IT remains a youthful although ageing profession (§2.5.3). IT employers still report difficulties in recruiting appropriate staff, despite significant computing graduate unemployment (§2.5.1). However as far as these student participants are concerned, the reality is that, because of offshoring of first-level posts, on graduation their first jobs will be harder to secure. As a result there are likely to be fewer people in their 20's in their workplace, than there would have been a decade ago. There is however recent evidence that there has been some movement of jobs back to the UK, away from offshoring, for reasons of control (Computer Weekly 2013). If this becomes a widespread structural change it should improve graduate opportunities.

Another aspect of computing which can profoundly affect its appeal to putative professionals is its gender balance, although this research was not designed to investigate issues related to the attractiveness, or not, of computing to girls specifically (§4.4.5). Evidence presented earlier shows poor female participation in schools computing (§2.3); poor and falling female enrolments in university courses (§2.4.2) and low and falling female employment in IT (§2.5.2). Clearly, if progress is to be made with recruiting more appropriate students onto HE computing courses issues of the appeal of computing to girls should not be ignored.

John recounted how a fellow student on his BTEC in Software Development had chosen to read Child Care at university, despite being very good at programming, since she was uncomfortable about the prospect of being one of the very few females on a university course. He said that she thought she would feel physically uncomfortable, and even threatened, in such a situation. Reports of a deterrence effect on women of the gender balance in IT have already been discussed (§2.5.2 and §2.6.2). For many girls it will diminish their agency to pursue computing as a career. Some would not have the self-confidence to work in such an environment and some, like John's friend, would simply not wish to be there. The gender structure of the IT workplace led to her feeling unable to apply. This is not a deterministic effect but, in line with Trauth's Theory of Individual Difference (§2.6.2), this particular young woman's response to her perceptions was to choose a different subject.

These participants of course each had their own individual impressions but overall they painted a picture of the employment structure of IT as being well-paid, male-dominated and looking to recruit older, experienced staff. Next, consideration will be given to participants' impressions of the nature and culture of the IT workplace.

5.4 Workplace and Work Culture

The character of IT employment is an important element in participants' perceptions of the profession. These views were clearly founded on the stereotypical image of IT work as being office-based and asocial, as reported earlier (§2.6.3) and described by, say, Woratschek and Lenox (2009). However their views and perceptions were much more nuanced than that.

Some participants (such as Michael and Victoria) felt that organisations sometimes design their working environment in such a way as to promote social interaction and enhance staff enjoyment. They felt this may be to allow employers to pay their staff less or to enhance recruitment. Some employers do look carefully at employment conditions in order to appeal to the best candidates

(Code.org 2013, Computer Weekly 2013). Some companies recognise that technical staff prefer, and may perform better with, an informal dress code, whilst others insist on business suits, for all staff (Computer Weekly 2013). Some participants recognised that by having a working environment which encourages networking between staff, employers are supporting the development of social skills and the development of an employee who is *"not just a bland person"* (Victoria-1#419) who will then be more productive for the company.

As well as perceiving informality in some working environments, some participants (such as Michael and Justin) were aware of flexibility in working practices. Some believe that being allowed to work remotely, from home, or having flexible working hours is quite prevalent. They see that developing such operational norms would give employees the impetus and agency to discharge their responsibilities in a way which they would find more rewarding. The informality of the IT workplace is a positive attraction to the profession. Justin commented:

"Google I think is one of the most successful companies in terms of employee production... because they just... they're so laid back yet it's so serious" (Justin-1#360).

Martin recognised that his view of IT professionals was largely based on his contact with his school's technicians.

"The stereotype around school or college [is that] they're just the people who stand in the smoking corner all the time" (Martin-1#409).

He saw a relaxed and laid-back culture suggesting, even, that maybe these people were rather negligent of their duties.

Not everyone saw IT employment as being so relaxed; some participants spoke about IT professionals being work-fixated. Jay, in his Wordle, pointed to working late nights being part of his perception of IT employment. Similarly, Victoria included an image (Figure



Figure 5-8: Late Nights

5-8) in her scrapbook saying that it reflected the culture of late nights.

Michael, who has already had experience of IT employment, and of working very long hours, described how it can be hard to relax and how your current task can become all-absorbing.

"So I mean you have to work quite hard but you are quite lazy in the fact that you don't do anything outside of work [...] You don't want to do anything else... because it involves effort. Your mind's already wired"
(Michael-1#230).

Whilst 'lazy' was perhaps not the most appropriate word, participants did not feel the need to challenge Michael's use of it. However, when prompted:

Interviewer: *"'Lazy' is really not the right word."*

Michael: *"I know. There's got to be a better word."*

Omar: *"It's uncompromising; focussed on work; work-aholic really"*
(Michael-1#232).

'Physically inactive' might be more appropriate for most of the situations described. However much work in computing is about problem solving, finding ways to achieve particular ends, designing and developing solutions. They are, in essence, logical puzzles and as such can be all-absorbing. Whilst the immediate driver for working long hours might be the desire to solve the current problem, this can have the effect of normalising long working hours. Of course the same can be said for much of the modern business world where employees feel the desire, need or pressure to work long hours. The IT industry may be little different from others in this regard.

Generally there was recognition that jobs in IT vary, with some being exciting and others far from that, but these jobs can be well paid. The appeal of working in computing may, for many, reside in their perception of the subject *per se* rather than their knowledge of the industry. Some participants recognise that employment structures and local norms affect one's ability to perform, as well as one's enjoyment of the job. They see that some IT employers also recognise this and use it as a recruitment incentive and as a result some big-name employers are, for some students, aspirational. Many realise that IT jobs can be relaxed

and informal although maybe also sedentary and requiring long working hours. Some of the implications of these perceptions of the IT workforce and workplace for the image of computing and on-going recruitment are explored in Chapter 8.

5.5 The Character of the Individual

Having looked at the structuring forces associated with the subject of computing itself and the image of IT employment, attention will now move to the individual and the extent to which identification with images of people in computing, their character and attributes, engage or deter young people. Using the ANT lens (Figure 5-9) revealed a network of relationships which influence a student's perception of computing. This will affect its appeal, which is the subject of the next chapter. Significantly, the stereotype of computing seems quite fixed and is based on, but not a totally accurate reflection of, the reality of computing. This stereotype affects a student's perceptions but this is moderated by any real knowledge they may have. A student's personal identity will also affect how they respond to such influences, thus affecting the perception they form. (This is discussed later, §8.2).

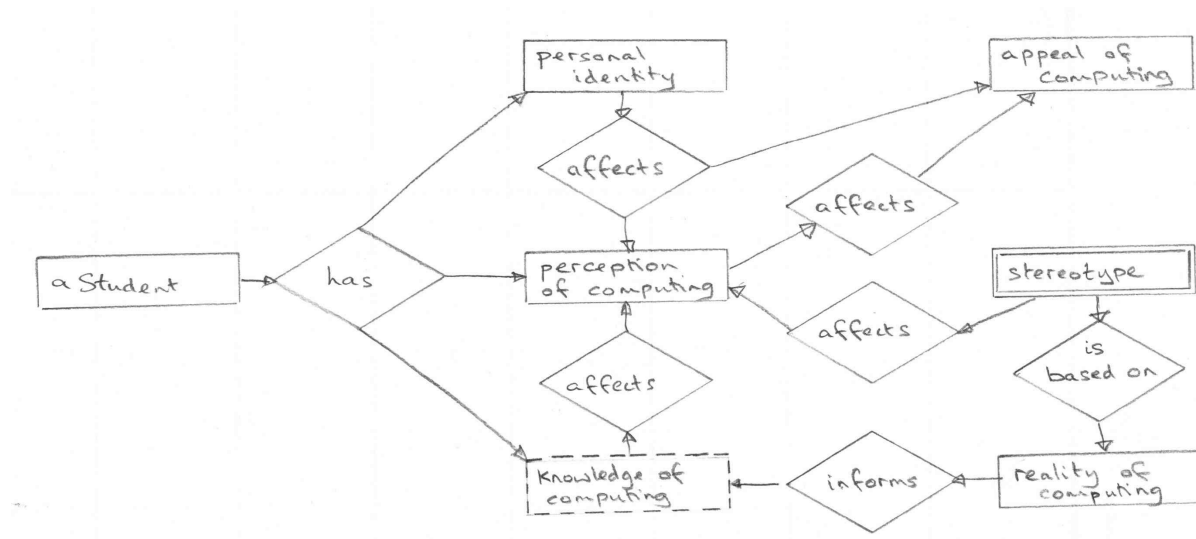


Figure 5-9: AAD of formation of the perception of computing

In the consideration of professional mathematicians, it is observed that "*imagery not only reflects but affects who goes into mathematics*" (Picker and Berry 2000:67): the stereotype is self-reinforcing. The same is probably true of computing: the image of existing IT professionals is likely to affect who chooses to join. The biggest issue here is of the association of computing with the stereotype of 'geek' or 'nerd'. Hence this will be addressed first, with other issues considered thereafter.

5.5.1 The geek or nerd?

The term 'geek' (or 'nerd') is often used in connection with people involved in computing (for example, Royal Society 2012) (§2.6.3). These terms often seem to be used interchangeably; however there are those who see them as distinct terms. For example, a 'geek' might be seen as an expert in some niche area whilst a 'nerd' is someone who is introverted, socially inept and takes their interests to extremes (Infographic Heaven 2012). However, many people fail to make any distinction.

Some participants saw geek as a term of gentle abuse; some did not even see it as being negative.

"Geekiness isn't a negative word. It depends on the way that you perceive it. In an industry like computing, 'geeky' is a very good one. Like I remember that Bill Gates said that: "make friends with geeks"³⁴" (Justin-1#592).

In connection with deciding which course to apply for, Carl acknowledged his fascination with computers, using the term 'nerd'.

"I kind of went: "Right I'm going to do this. And I know I can do this because I'm a nerd with computers, but I don't know that much about them yet and I want to" " (Carl-2#154).

And:

Justin: "[Fellow sportsmen] say: "it's well-easy to do computing". So I don't know what... they still call me a 'geek' though."

³⁴ Probably refers to: "*Be nice to nerds. Chances are you'll end up working for one.*" http://www.brainyquote.com/quotes/authors/b/bill_gates.html

Interviewer: *"Yeah but in a friendly way?"*

Justin: *"Yeah"* (Justin-1#651).

In considering the image of the Network Administrator (Figure 5-7), Innocent observed: *"it's geeky"* (Innocent-1#509). This was in response to an image of a man with round glasses, working with racks of devices and cables, smiling happily. He appears to enjoy his work and there's nothing in the image which suggests that he lacks social skills. As Justin later observed:

"it's meant to look um geeky and uninteresting, yet he has a smile on his face which shows that it's very interesting to him" (Justin-1#570).

Some believe the term geek is used to exert power – to attempt to redress the power balance – where one person has superior skills, especially if the other person values or aspires to them.

"I've got called a geek a few times at school... I want to be a software developer and I had a couple of people call me a geek. But I said I'll be the one who's laughing when I'm programming your games" (John-1#295).

And:

"It's basically they're not able to do something by themselves and, if someone else manages it well... it's kind of a competition" (Matthew-1#307).

Some see it as a way of gently teasing those who do more than is really needed, such as going beyond the requirements of an assignment or being obsessive.

Innocent: *"Let's say, in Uni when you have to code [...] an etch-a-sketch. All they did is have one that you go up, you go left, you go right, you go down [...] That was it. And, this other person, they did one where... you actually can program your own in a text file and it changes the colour and everything. But why do people have to do that?"*

Interviewer: *"You mean why did they have to do more than was needed?"*

Innocent: *"Yeah"* (Innocent-1#578).

And:

"I would think geekiness is a[n] obsessive-compulsion to break things down, find out how they work for no reason whatsoever" (Innocent-1#614).

Use of the term is not entirely confined to technical areas. Martin was called a geek at school for being pernickety about English grammar and endeavouring to get it right. Some participants (such as Justin, Martin and Michael) reported that they did not really mind being called a geek since they see it as a mild term, and one which acknowledges their expertise, although Chris commented:

"I'd rather not be, to be fair but... it depends like if it... how you say it"
(Chris-1#659).

A comparison with sporting prowess is interesting:

"In sport, I believe, if someone's better they may sometimes look down on the weaker ones. But in computing seems it is the other way. If they're not better at what I'm doing they'll try and look down on me" (John-1#323).

John thinks that there is an inverted pride with computing expertise, such that sometimes those without well developed skills use terms such as 'nerd' and 'geek' to mock those with more skill. This supports the observation from Bell and Corner (2011) (§2.6.3) that its use can be a deferential acknowledgement of expertise. It is interesting that Matthew said that there was no such phenomenon in his home country in Eastern Europe.

In connection with geeks, Michael observed:

"I never really saw myself as one even though I probably am [...] I tell you a lot of people [i.e. students] probably think that. It's like well: "Yeah [computing students] are generally geeks but, well I'm not really." Even though deep down inside we all sit at home and do programming when we could be out having fun [...] I mean this is it. We are geeks but it doesn't mean we're only geeks. We can be more [...] You're not just one thing. I'm not just a computer student" (Michael-8#268).

Most participants realise that the stereotype exists but that not all professionals fit it and some believe that they may be less common now.

"The stereotypical programmer that I've seen likes logic. Tends to be very logical about things; tends to have a very dry sense of humour and spends most of his time coding and doesn't really have great social skill. As I say I'm not sure that that applies to many programmers now but that's the stereotype... certainly" (Martin-1#181).

Indeed like Michael, Martin sees his behaviour may sometimes have fitted this.

"I recognise it and I think I was possibly part of it at one point [...] You get up and I'd go downstairs into my backroom and spend the whole day there and have to surface for meals every so often but that was about it really. So I'm quite aware of how that stereotype develops" (Martin-1#405).

However the term 'geek' can be given many interpretations. Some saw the term as implying poorly developed social skills or being unsociable; some saw it as implying technical expertise and some saw it as referring to work-obsession. A few participants (particularly Martin and Michael) acknowledged that an external observer might see such tendencies in themselves. No participant expressed the view that these were desirable employment attributes: indeed the implied premise was that they were not. Participants recognise that the degree of abuse intended is conveyed by the way in which the word is used, rather than by its use *per se*, although all participants saw the term as quite mild, at worst.

However, to some people, the term 'geek' can invoke some quite negative imagery. When interpreted with this signification it is not surprising if the geeky image is deterring some from joining the profession (§2.6.3). John asserted that some people are influenced by a negative portrayal of an anti-social loser, although he does not think that it deters them (John-1#65). Emma gave quite a lot of prominence to the term 'geeky' in her tagcloud (Table 5-1f): she was the only participant to do so. It is interesting to wonder if this could be an element in why she ultimately decided not to study computing. It is reported that girls in particular seem to not want to be perceived as a geek (Carter *et al.* 2009, Margolis and Fisher 2002). For some people, of either gender, it seems likely that this is not an image that they wish to associate themselves with: it does not fit with any identity they wish to adopt. Whilst the geek identity could well be off-putting to many, for some participants in this study they chose the subject despite the label.

Michael: *"You accept the good with the bad."*

Interviewer: *"Do you see yourselves like that?"*

Omar: *"In some cases" (Omar-1#156).*

The situation may be changing though. People are seen wearing T-shirts proclaiming '*I am a geek*', there are geek fancy-dress parties and round, heavy spectacles are promoted. However the use of geek iconography in fashion does not mean that geeks themselves have become more accepted nor that geeks are claiming the term. It might just be a trend which will pass.

However there may be some moves towards claiming the term. Professor Donald Knuth, a CS luminary based in the US, recently commented that the use of the term 'geek' is changing and some people are self-identifying as geek: 'geek' has become chic (Knuth 2011). Also in the US, Hewner and Knobelsdorf (2008) reported some students can be excited to embrace this identity. There is some evidence of geek chic in the UK too. In Manchester a popular, introductory programming course for girls is being promoted as 'GeekGirls' and, as noted earlier (§2.6.3), Bell and Corner (2011) observed that the image of the geek can attract those who either want to be part of a geek culture or to remain as outsiders and non-mainstream.

As previously discussed (§2.6.3), there seems to be little consensus as to what the term 'geek' means, even amongst participants in this study who are all personally involved in computing. Some accepted the label but were quite neutral or reluctant to emotionally 'own' it. This could be, in part, a self-protection mechanism: a way of avoiding identifying with a term with which they do not wish to be associated. This is discussed further in Chapter 8. However there are personal characteristics, other than geek, which participants associated with IT.

5.5.2 Other characteristics

Views were raised about a number of social and inter-personal aspects of IT work and employees. In the Image Competition (§4.5.4), Raith submitted a photograph³⁵ showing the creator of Facebook, Mark Zuckerberg, meeting US President, Barack Obama. The competition was for images which reflect the students' view of the excitement of the subject. Raith's explanation for the selection of this image was that, to him, Facebook is the ultimate representation

³⁵ The image submitted is copyright but is at: http://www.cbsnews.com/8301-503544_162-20055817-503544.html

of computing leading to a changed world. He thinks that potential students could relate to Zuckerberg, as an ordinary person who enrolled on a CS degree, and hence this image might inspire others.

"He is a surprisingly relatable figure with whom I'd imagine many of those determining what they wish to study could relate to and be inspired by" (Raith-1).

It is Zuckerberg's ordinariness and relatability that Raith says he is focussing on. However by selecting an image of Zuckerberg meeting Obama, Raith is foregrounding Zuckerberg's wealth and prestige, perhaps to latch on to what he perceives as applicants' likely aspirations. He is trying to encourage applications for computing courses, by suggesting that an ordinary, agreeable person could become the creator of a valuable online phenomenon like Facebook, but also that such people can be successful in IT generally.

There was suggestion that people in IT are unsociable. As Victoria observed that: *"if it's just you, programming, then you kind of lose your social skills if you do it for like long periods of times"* (Victoria-1#195). Omar appreciated that social skills are important for employability.

"[In] most industries today you can't really be unsociable. I mean probably before, when computing was quite new, you could be quite unsociable because you were focussed on one task. But since computing is next to business, I'd say you have to have that sociable side: you have to interact with customers, talk to them and get to know them" (Omar-1#270).

Similarly, Dave in his tagcloud and Jay in his Wordle also signalled the importance of social skills in their view of computing.

Some participants had clear views of the nature of working in IT, largely derived from their social capital in the form of their contact with people employed in IT. The views offered do not paint the picture of an employment area which would seem particularly attractive. They painted a picture of work-focussed individuals who are inactive and have little social contact (although many recognised the importance of good interpersonal skills). There was some diversity of impressions though, with some participants pointing to the ordinariness of employees and maybe a relaxed attitude to work. IT roles are diverse and call

for a range of personality and skill types. Loogma, Umarik and Vilu (2004) identified a spectrum of role types in IT: geek, techie, flexible specialist, translator and transgressor, of which the 'geek' is just one. Of course this use of the term has a meaning assigned to it by the authors as a label for certain sorts of roles, and may not correspond to an individual's understanding of the term. Nonetheless, whilst diversity was not explicitly explored with participants, it does seem that many are unaware of this range of possible roles. They do not seem to be evident to outsiders and it may be useful for recruitment if they were.

5.6 Conclusions

In this chapter we have seen that computing is viewed in a range of different ways, even by these participants who are all, to some degree, enthusiasts. Nonetheless some general tendencies and findings emerge. The difficulty with the image of computing relates not just to the stereotype of the people inhabiting the profession but also the perception of the nature of employment opportunities. The implications for the IT profession, and recruitment to computing courses, are very significant and will be explored when looking at course choice, in the next chapter, and later when responding to the research questions (Chapter 8). The detailed findings with regards to image follow.

- Evidence from participants shows that youngsters' positive relationships with computing can be established at a very young age and can be enduring. Whilst this suggests that it may be important for early experiences to be good ones, the issue will not be pursued further.
- Some participants are clear that their motivation is intrinsic, based on anticipated exciting challenges. It is, of course, not always seen as being dull, as is sometimes reported. For some the motivation is more extrinsic, perhaps particularly based on aspirations of large salaries.

- These participants primarily see computing as a practical skill. They do not foreground theoretical underpinnings and knowledge.
- In line with existing literature, the evidence suggests that programming can cause significant anxiety and difficulty to new learners. However for many computing courses it is a threshold concept subject.

Student expectations with regard to these three, and other, issues and the impact of misalignments with their courses' content, are explored in Chapters 6. The possible consequent student disengagement is discussed in Chapter 7.

- Many students were pleased that their course allowed them to exercise their imaginative creativity. However many projects in IT are often very tightly defined by client requirements. IT professionals, and therefore students, need to be able to deliver those. Requirements form a strong structuring force limiting the agency of those who need to deliver them. This is explored further in Chapter 7.
- Participants, including enrolled students, agreed that the geeky stereotype is widely known and confirmed previous reports that it can deter some applicants. However it is clear that there are also more subtle ways in which the geek imagery can have impacts in ways which are not always negative. The impacts of the imagery in relation to identity, skills acknowledgement and ego are explored in Chapter 8.
- It is very well known that computing has an (at least somewhat) incorrect external image and many people do not know what the subject encompasses. The frequent confusion with ICT is explored in Chapter 6. Also it is widely acknowledged that recruitment would benefit from a wider understanding of the diversity of IT employment opportunities.

- This research confirmed that students know very little about IT employment and the range of opportunities. Many students who do choose computing do so because of their knowledge of computing, rather than their perceptions of employment.
- Students have some impressions about the IT workforce (largely based on the geek stereotype) although, as with their perception of the age profile, these can be incorrect.

These three issues will be considered further in Chapter 8 in considering the broader implications of the current image of computing. The public understanding of the nature of computing will dramatically change (in the UK) when a revised National Curriculum is introduced into schools, which is discussed in Chapter 9.

6 : Course Choice: Are Some Students Pooh- Sticks?



Pooh-Sticks³⁶

³⁶ A. A. Milne (1928) *House at Pooh Corner*. London: Methuen

6.1 Introduction

Having considered the image of computing, this chapter moves to the theme of choice and investigates the emergent influences on pupils' decisions as to whether to apply for a computing degree. The research question on which this chapter is based is:

What factors lead school pupils to choose to study a computing course at university? This includes the extent to which it is an active choice and the sources of advice and information which they use.

Much about the process of course choice will be generic, applying to most subjects, and hence attention will focus on issues of particular importance for computing. Yorke and Longden (2008) identify four main reasons why students sometimes enrol on an inappropriate course: pressure to enter HE, drifting in, uncritically being guided by their A-level results and a poor alignment between their preparation and degree programme. The first of these was not detected in this research but, as will be seen, the other three were.

As with the previous chapter, this chapter commences with two tables. Table 6-1 shows the sources of the data codes underlying this chapter's theme. Table 6-2 presents the way in which the various data items informed the derivation of the chapter's theme and four sub-themes. This table also indicates the ways in which the theoretical lenses informed these sub-themes, and their constituent categories.

This chapter embraces four sub-themes. The first relates to students' choice experiences in school. They may have progressed through school as if they were on an educational conveyor belt, with the choices and decisions they have needed to take usually being relatively minor. The second sub-theme, allied to the conveyor, illustrates that a few students progress to, and through, university as though they were a Pooh-stick. They exercise very little agency and simply go wherever the 'current' takes them and, as will be described in Chapter 7, this may not always lead to a positive outcome.

Many students appear to enter HE computing courses and encounter content that they did not expect. So the third sub-theme shows that there is a range of

diverse routes by which pupils might come to understand the nature of computing: the family is found to be particularly significant. However it is evident that a minority of pupils embark on a computing course misunderstanding what it is about. The final sub-theme therefore highlights the sorts of misalignments that exist in students' expectations.

Sources of data: theme CHOICE				
	Sub-theme			
	Choice experiences in school	Progression to and through university with little agency	Routes to gaining understanding	Misaligned expectations
Study sources				
Preliminary		careers advice, course choice, family influence	computing in schools, outreach experiences	computing v ICT, course choice, ICT A-level, programming
Longitudinal	choice process, confidence, course choice, entry requirements, family influence, independent, option choices, support	career knowledge, careers advice, choice process, course choice, course options, family influence, first generation, influences, interest in computing, support, teacher supportive	choice process, computers at home, computers - primary school, first computer, school computing, university open days	computing v ICT, course choice, ICT A-level, ICT GCSE, programming
Focus group	choice process, confidence, course choice, empowerment, family influence, independent, role models	attitude to university, career knowledge, choice process, confusion with ICT, course choice, course options, degree needed, friends who could have, influences, interest in computing, lack of career focus, motivation, think they know about computers	choice process, computers - primary school, family exposure, family influence, first computer, how things work, role models, school computing, taster course, university open days, young age activities, young age views	career options, competence, confusion with ICT, course choice, employment requirements, expectation, programming, programming aptitude, public information about computing, speed of change, think they know about computers
In-module	course choice, family influence	attitude to education, choice process, course choice, motivation, interest in computing	choice process, outreach experiences	confusion with ICT, course choice, programming
Engagement	course choice, choice process,	career knowledge, choice process, course choice	choice process, computing in schools, young age activities	computing v ICT, Computing A-level, course choice, expectation, ICT A-level, ICT GCSE, programming
Image participants		influences		programming

Data sources				
1:1 interview	choice process, confidence, course choice, entry requirements, family influence, independent, option choices, support	attitude to education, career knowledge, choice process, course choice, course options, family influence, first generation, influences, interest in computing, motivation, support, teacher supportive	choice process, computers at home, computers - primary school, computing in schools, first computer, outreach experiences, school computing, university open days, young age activities	career options, competence, computing v ICT, Computing A-level, confusion with ICT, course choice, expectation, ICT A-level, ICT GCSE, programming
Group meeting	confidence, course choice, empowerment, family influence, role models	attitude to university, confusion with ICT, course choice, course options, degree needed, friends who could have, influences, interest in computing, lack of career focus, motivation, support, think they know about computers	computers - primary school, family exposure, family influence, first computer, how things work, outreach experiences, role models, taster course, university open days, young age activities, young age views	career options, confusion with ICT, course choice, employment requirements, expectation, programming, programming aptitude, public information about computing, speed of change, think they know about computers
Image competition		influences		programming
Image tagcloud				
Wordle™				
Image collection (used in focus groups)		degree needed	family influence	career options
'Images of computing' scrapbook				
How did you decide: Pyramid of career influences	course choice, family influence	attitude to university, careers advice, family influence	choice process, school computing	

Table 6-1: Sources of data: theme CHOICE³⁷³⁷ Not all Data Sources applied to this theme

The derivation of theme and sub-themes: CHOICE				
Sub-theme	Category	Codes from text sources and ideas from lenses and other sources	Example quotations and examples of sources	Category informed by analytical lenses
1. Choice experiences in school	Guidance and support	course choice, empowerment, family influence, independent, role models, support	"well nobody really... I just sort of try my best"; "his life in his own hands"; "massive influence from my parents"; "my immediate family is quite supportive"; career influences pyramid (Myndtrick see Figure 6-3)	ANT S&A TSP
		Parental pressure and expectations provide a structuring force constraining the agency of choice	Structure and agency lens	
		Family may lack the social or cultural capital to provide specific advice but can convey aspirations through their habitus	Theory of Social Practice lens	
	Educational choices (choosing options)	choice process, confidence, option choices, entry requirements	"we had to choose one out of each box"; "wanted to keep my options open"; "I figured out what I needed"; "I went with my best grades"	ANT S&A TSP
		school processes guide towards continuation; lack of experience of choosing leads to a lack of experience in exercising agency (in an educational context); pupils' agency is constrained by the heavy structuring of option choices	Structure and agency lens	
		staying on in education and applying to University is now the norm and natural	Theory of Social Practice lens	

2. Progression to and through university with little agency	Guidance and support	attitude to education, attitude to university, career knowledge, choice process, family influence, first generation, influences, support, teacher supportive	"my sister said I should go"; "be the best you can"; "I was talking to my teachers"; "now I have gone off the idea of university"; "he was particularly influenced by his friends"; "I don't think I had any advice"; "my parent don't think education is very important"; career influence pyramid (Michael and Victoria see Figures 6-4 and 6-2)	ANT S&A TSP
		for some, family structure left student free-enough to exercise independence; parental pressure provides a structuring force to apply and succeed; some young people exhibit little agentic behaviour but go with the structuring forces around them; school processes guide towards application	Structure and agency lens	
		an individual's social capital affects who is available to provide information and guidance; cultural capital (maybe parental education) helps pupils be aware of the benefits which can accrue from university attendance; weak social and cultural capital may prevent a student from realising that their outcomes may be improved if they engaged with their choices more	Theory of Social Practice lens	
	Interest and motivation	interest in computing, friends who could have, lack of career focus, motivation	"I've always been interested in computing"; "[my friend] thought they wouldn't manage it"; "I like looking at things that have got potential"	ANT S&A TSP
		structuring force of previous achievement can limit consideration of ongoing interest or consequences (eg choose it only because good at it)	Structure and agency lens	
		habitus leads to differing expectations and aspirations	Theory of Social Practice lens	

	careers advice	careers advice, degree needed	"some companies insist on a degree"; career influences pyramid (Scarab see Figure 6-12); image collection	ANT
	university and course choice	course choice, course options	"this isn't what I wanted"; "this particular course was broad"; "I like loads of options"	ANT S&A TSP
		university entrance is seen as the norm for those who are capable; some students appear not to have looked at course content in any real way, not even the prospectus	Structure and agency lens	
		cultural capital is required to be aware of the differences between universities and to make a fully informed choice	Theory of Social Practice lens	
	credibility as an academic subject	confusion with ICT, think they know about computers	"[computing] is not worthy-enough as a degree"; "a doss degree"	

3. Routes to gaining understanding	exposure via family or at home	computers at home, family exposure, family influence, first computer	"my dad used to do loads of stuff in his free time"; "my uncle told me"; "a lot of it was to do with things at home"; "my uncle used to own a computer shop"; "my dad was fixing computers at home... I was interested"; career influences pyramid (Victoria see Figure 6-2); image collection (see Figure 4-10)	ANT S&A TSP
		structural advantage of expert relatives lead to opportunity to be excited by computing enhancing their agency	Structure and agency lens	
		expertise may exist within a young person's sphere but they will not benefit unless suitable social structures are in place (the resource will not mobilise into capital)	Theory of Social Practice lens	
	personal investigation and experimentation	how things work, young age activities, young age views	"when I was a kid I thought: how do they work?"; "fascinated with what you could do with it"; "fascinated by it"; "I spent a lot of time developing what I knew"	ANT

	exposure in school - computing activities	computers - primary school, computing in schools, school computing	"it was more technical based [than ICT]"; "if something went wrong I'd try and fix it"; "we had these logo robots... I used to love that"; "I had an ICT teacher and he really showed me what you could do with computers"; career influences pyramid (Dave, Jessica and Victoria see Figures 6-11, 6-7 and 6-10)	ANT
	exposure in school - advice sessions/teachers	choice process	teacher clarified the difference between Computing and ICT A-level options, "you want to specialise but not too much"; career influences pyramid (Victoria see Figure 6-10)	ANT
	other routes to understanding	university open days, outreach experiences, choice process, role models, taster course	"there was a taster course and I decided this was for me"; "I realised this was not quite what I wanted"; "I looked at the videos on the website"; "it's about young people's perception of computing"	ANT S&A TSP
		social structures, typically supportive parents, can help youngsters access various experience opportunities	Theory of Social Practice lens	

4. Misaligned expectations	The unexpected?	career options, course choice, expectation, public information about computing	"this isn't what I wanted"; "this course is broad"; "I often thought computing was quite restricted"; "I had researched the modules of the course"; "I didn't think we'd be taught something like that at Computing"; "I don't think most people would be interested"; image collection (see Figure 5-7)	ANT S&A
	confusion with ICT	Computing A-level, computing v ICT, confusion with ICT, course choice, expectation, ICT A-level, ICT GCSE, think they know about computers	"I just thought it was the same thing"; "I enjoyed ICT so I knew I wanted to continue with [computing]"; "that was surprising"; "they assume it's ICT"; "[people think] you can just do [computing] by experience"	S&A TSP

		multiple meanings of term 'computing' in different contexts - differing interpretive schemes - leads to misunderstandings about the nature of the academic subject of Computing, which can lead to poorly guided agency	Theory of Social Practice lens; Structure and Agency lens	
	Programming content	programming, programming aptitude	"Games is more on the programming side but I'm more interested in 3D modelling"; "don't want it to be too raw in terms of programming"	S&A
		some applicants are keen to find a course which involves no (or minimal) programming	Professional practice	
		many applicants will not have seen any programming, and even that will tend to be application-based; some students do not expect programming	Preliminary Study	
	You've got to keep current (with technology)	competence, course choice, employment requirements, speed of change	"we want to feel the course is really up-to-date"; "it's very fast-paced... constantly moving"; "you've got to keep on learning"	S&A
		poor alignment between employers' requirements and university curricula	Structure and Agency lens	

Table 6-2: The derivation of theme and sub-themes: CHOICE

This chapter is ordered by the spheres of influence on course choice and these sub-themes. First, attention will be paid to the family and their role in guidance. Attention then moves to school, particularly pupils' progression through school and the option choice arrangements. Since most young people get no exposure to computing at school (Chapter 2), some of the routes by which youngsters might get that experience are then explored.

The previous chapter explored how youngsters see the discipline of computing which will be further developed by considering their expectations of a computing course. The final section considers how pupils choose computing and, as this

research revealed, many students go through this process as though they were Pooh-sticks.

6.2 The Sphere of the Family

Viewed through the actor-network lens there are three ways in which the family can be seen to influence a student's choice of a university course in computing: guidance, support and IT exposure at home (Figure 6-1). These relationships will be explored shortly.

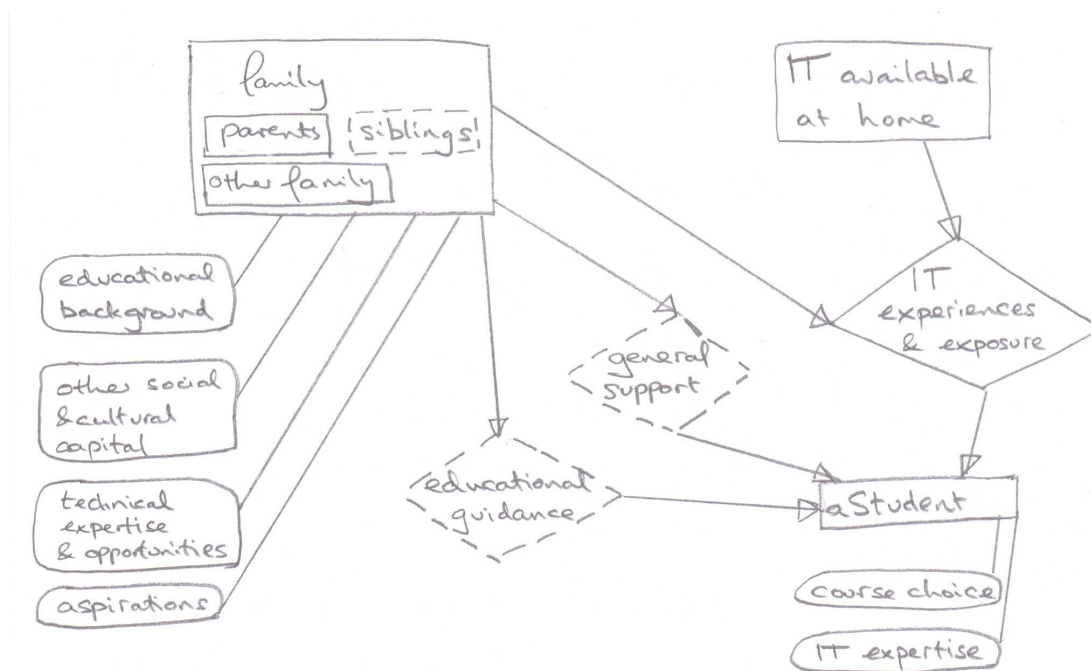


Figure 6-1: The role of the family in choosing a computing course

As well as being viewed as an actor in its own right, the family can be seen as being composed of a number of actor-elements: parents, siblings and other family. In this family actor-unit the parents are often the pre-eminent influence but other adult relatives can be important too. In ANT terms, the family is not a fixed, immutable object. In this project many participants spoke of parental

break-up and, sometimes, step-parents. The family is thus fluid in nature and, of course, each is unique.

The family provides a very powerful structuring force in almost all children's lives. It gives the young child a basis for understanding and interacting with the world. Children's early socialisation into the world starts with their family, with those people who care for them. As the child gets older other agents enter into this process: peers, teachers, the mass media (Macionis and Plummer 2012). They develop their own habitus (§3.3.2), their own values and opinions, but in the early years of their life a child's perspectives are profoundly affected by the views and norms, the collective habitus, of their family (Clark and Zukas 2012). As Bourdieu observed: *"on the basis of this combination of experience and cognition, each of us develops a practical disposition to act in certain ways"* (Calhoun 2000:709): our own habitus. For instance, if parents do not value education, then the child is unlikely to either. Based on their habitus families have differing aspirations and expectations and, heavily influenced by their family, so do young people. This is true of many aspects of life, including education and course choices (Lang 2012). Habitus is significant in shaping life events generally. Along with contextual and personal factors, such as gender, family composition and much else, habitus *"underlies the structuring of all subsequent experiences"* (Clark and Zukas 2012:unpaginated). This study identified routes by which families have influenced a students' course choice, which will be examined in turn, starting with guidance and support, followed by IT experience.

6.2.1 Guidance and support

For many students, the educational guidance and support received from their family is significant. As will be discussed later (§6.4), the family can be crucial in that it can form the main, or only, mechanism by which students come to see computing as their preferred career route.

During the Post-It pyramid activity (§4.5.5) several participants identified one or more parents as being their most significant course choice influence. Victoria spoke of how her parents had guided her to take Computer Science rather than

ICT (Figure 6-2). For many participants, including Jason, Joey and Charlie, a parent brought their personal experience of computing into the process. For these participants, one or more parents provided a strong input: there was a powerful guidance association between the student and the family actors. For some a non-parental relative was important, such as John's uncle and Michael's sister.

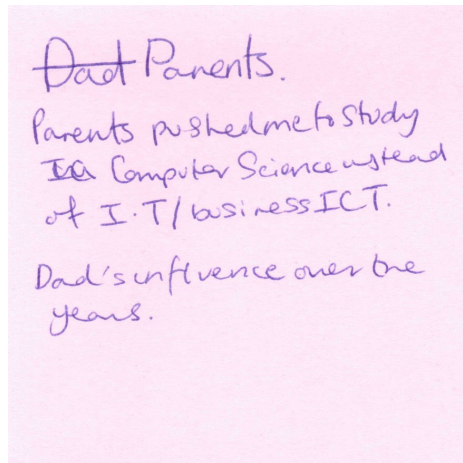


Figure 6-2: Extract from Victoria's pyramid of careers influences

However, not every participant received guidance from their family. Alex described how his parents were barely present in his choice making. In recent years he has lived with his younger brother and blind father. His parents, though separated, are both still in his life. Whilst neither had been to university neither had figured in his educational choices, even in earlier years. In discussing his GCSE option choices:

Interviewer: "Who helped you make those decisions?"

Alex: "Nobody really. I sort of decided that on my own. I went on what subjects I loved" (Alex-1#356).

This family appears to operate with very little by way of social or cultural capital. Alex's father has not worked since he lost his sight before Alex was born but even prior to that his employment had been routine and semi-skilled. "My dad was reasonably unsuccessful I think" (Alex-1#563). For Alex, his dad is an anti-model (Gunter and Gunter 1990) and he aspires to be different. Whilst young

people are not exempt from caring responsibilities, Alex has grown up taking a degree of self-reliance and responsibility not required of most youngsters. He is quite remarkable and is managing to progress despite difficult family circumstances. *"I just sort of try my best"* (Alex-1#217). The structure of his family situation, whilst providing little support or guidance, is simultaneously free-enough to give him the power to exercise independent agency in his educational choices.

In line with the position nationally very many participants are, or will be, first-generation university students (Stevenson and Lang 2010). Clearly there are limits as to what guidance on university choice most parents, but particularly those of first-generation students, can provide. However, some families have, as part of their social capital, others who can help, maybe an older sibling, relative or friend. In ANT terms, the guidance relationship between student and family, can be considered to be 'fire' (Figure 6-1): an 'absent presence'. Thus, whilst many students benefit from familial guidance this is not always the case. In contrast, in families with high levels of cultural capital, in particular in the form of parental education, applicants are more likely to be aware, for instance, that all universities are not equally prestigious and are more likely to aspire to attend an elite institution (Stevenson and Lang 2010, Yorke and Longden 2004). Such influences were not detected during this research, though the route by which participants were recruited would have made it unlikely.

Even if parents and families lack the necessary social or cultural capital to provide much by way of specific advice as to what subject or course to apply for, they can still convey the aspiration to engage with HE, their views about computing careers or support in other forms. Myndtrick reported his parents as the most important influence in his career planning by setting him high standards to aim for (Figure 6-3).

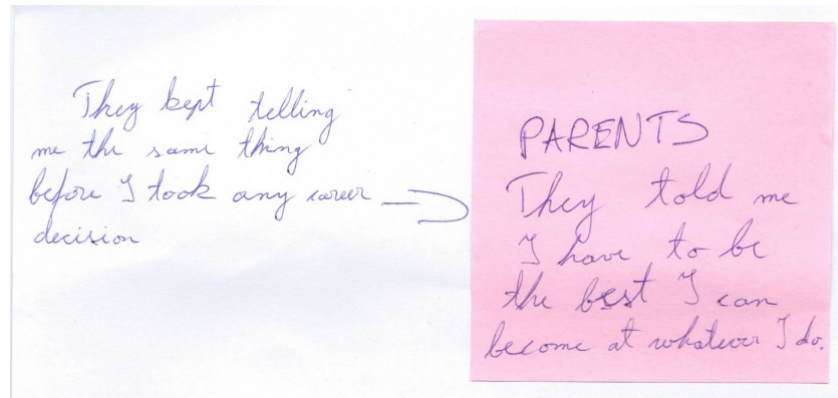


Figure 6-3: Extract from Myndtrick's pyramid of careers influences

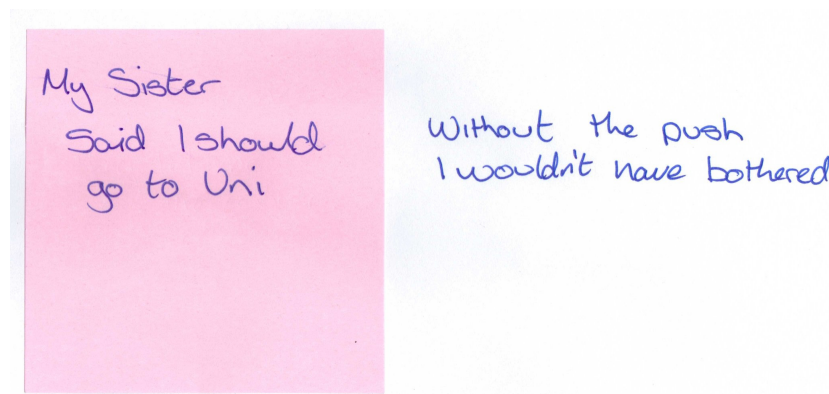


Figure 6-4: Extract from Michael's pyramid of career influences

For Michael, it was his older sister who was particularly significant in providing the necessary impetus (Figure 6-4). She had started university but had had to withdraw, is currently studying again and is clearly sensitised to academic achievement. Their parents, who had very little schooling themselves, provided some motivation by a different mechanism. They had led Michael to believe that little was expected of him academically and hence gaining a degree would be to prove his parents wrong.

"The fact that my parents think I'll fail is also a bit of a motivation"
(Michael-7#73).

For both Myndtrick and Michael the 'support' was in the form of pressure to achieve. For many, the parents' role seems to have been confined to acting as

chauffeur or providing reminders to deal with their university application (for instance, Dave and Rebel).

Teken, is from an advantaged family. Whilst being uncomfortable about describing any family in this way, it does seem apposite. His parents are both graduates and the family has high levels of social, cultural and economic capital. Teken's parents' role in the university application process seems to have been largely confined to providing transport to Open Days. These parents will also have been communicating their expectations and aspirations, even if not explicitly articulated. Teken explained their hands-off approach as his parents trusting his maturity to make sensible choices. His parents might change their stance if he made a choice which they found alarming but it appears that they felt confident-enough to be able to distance themselves from the immediate events and details. Superficially they are the opposite of the stereotypical, middle-class, educated parents, who are often characterised as being controlling, and whose attitude can be portrayed as the parents protecting the investment they are about to make in their offspring's education (Beswick 1989). Teken's parents are allowing him to exercise his agency and giving him the chance to develop his independence. They may be as keen as many other parents to ensure that he succeeds academically. However, parental support is not always present, for example for Alex. Thus like guidance, support is an ANT 'fire' association between student and family (Figure 6-1): available in some families, but not all.

Within the family, expectations can be seen as a powerful structuring force, guiding and maybe constraining agency in educational choices. None of these participants had reported feeling pressurised to apply to university. (Of course, any young person who was resistant to university entry is unlikely to be a participant in this study.) However sometimes it was clearly a family expectation that they would apply (for example, for Dave and Teken): there was an element of power being exercised in guiding their agency. It was the norm and it was understood that this was what they would do, but it was not evident that any of these participants recognised this influence. Family guidance and support for university application are likely to apply similarly in most disciplines and hence will not be explored further.

6.2.2 IT experiences

As well as support and guidance, the other significant way in which the family influences a student's course choice of computing is through the IT experiences the student has at home. All participants in this research have had access to a computing facility at home, at least over recent years, leading to a normalisation of interaction with computers: computers are simply part of their lives. This is to be expected: most homes in the UK now have a home computer, and possession will be most prevalent amongst those with young people. In 2011, 80% of UK households owned a computer (ONS 2013) and 77% had internet access (ONS 2012). For participants, the nature of their home computing provision as they grew up varied, widely. For some it was quite modest but other households provided much more and updated it regularly. Thus the association between a student and their home IT can be viewed as being 'fluid': present but changing over time (Figure 6-1).

Many participants recounted how those home experiences had directly kindled their interest in computing. The experience provided within the family, for many, led to familiarity and skill in using home computers over and beyond that experienced through the school curriculum. Sometimes, this exposure engendered a curiosity, not just in what computers could be used for but in how they actually worked. A few developed their understanding simply by trying things out for themselves, largely unsupported.

"...when our family got like our first computer. Obviously I was really young then, I can't think how old I'd be though. It'd have been years and years ago now, before 2000 so I was like... I was just fascinated with how it worked and like what you could do with it" (Chris-1#19).

"Since I was young technology has like... has been a big part of my life. When we first got our computer I was just fascinated by it, the computer architecture and how the computer works and why it works when I press certain buttons and just, um, different stuff like CMD³⁸" (Justin-1#41).

Martin had his own computer from age 8. However he only developed an interest when he was given a more powerful machine a few years later.

³⁸ The 'command processor' instruction

"Once we got our new computer, and it was all very... it was like, what was it, 1.56GHz or something. It was very slow but at the time it was extraordinary at 512M RAM and a 40G hard drive. [...] So we had this thing: that's when I really got to know about how stuff worked" (Martin-1#65).

In some families the young person explored to the extent that they became the IT expert in their family.

"I was teaching my dad and he was just like: "yeah but you can't point and click in there. It's not as [much] fun" " (Martin-1#73).

One participant, Alex, had access to a home computer but little other technology – he may be the only participant who did not own a mobile phone, for instance. Despite this limited domestic access to technology he understands what the subject of computing is. It is not clear where this understanding originated. After giving Computer Science serious consideration he applied for a degree course in Mathematics instead. It might be that his limited exposure to the wide range of opportunities in computing had failed to whet his appetite thoroughly enough or simply that Mathematics seemed more interesting.

The student's experience of, and enthusiasm for, computing in the home will be also be affected by parental background. Parents who are themselves well-versed in IT and computing are likely to encourage their offspring to explore and develop new skills. Many participants spoke of a parent or other family member as having been influential in developing their enthusiasm and interest in technology. Teken's involvement with computers started at a very young age, initially using software written by his father.

"[My father] built the first game I ever played on. Very simple games like: "click this box and it'll change yellow": that kind of thing. So I started using computers when I was very young. As far as I remember, at about two" (Teken-1#104).

Early in his secondary school years Teken went travelling for an extended period with his family.

"I spent a lot of the time I was away [...] practicing my IT; I spent a lot of time developing what I knew" (Teken-1# 558).

On his return, aged 13, he persuaded his school to let him set up an after-school computer club so he could share his self-developed expertise with his peers.

"Yes, I find it quite simple because I've spent a lot of time learning and practising it. But other people don't have this idea and I got irritated with it. So I formed the IT Club so I could pass on the extra knowledge I had learnt at that time, to other students so they can appreciate that software developers and people will spend hours developing for computers" (Teken-1#568).

He was still running that club five years later when he left the school. Teken developed his knowledge of IT through personal exploration but this was started and supported by his father.

Omar's uncle owns a computer shop and he regularly witnessed computers being assembled and Victoria's father is an IT consultant and witnessed computer problems being investigated for work, but at home. Charlie's mother works as an IT developer for a local authority and this provided him with experience of very many new technologies.

"When she comes home and she brings like you know new gadgets like the iPad2 and laptops and stuff. And it's easy for me to just get interested in it and have a look" (Charlie-1#117).

The activities which these participants witnessed through their relative's employment helped them form a view of the nature of the subject and an insight which could spark their interest and curiosity. These relationships, as well as providing exposure, gave these young people an accessible source of computing expertise which probably was deeper than that available within most families. They had access to advice and knowledge and, for some at least, to less-widely available resources such as webcams or scanners or early access to the internet. But most particularly, this structural advantage would have made it more likely that that they would be inspired by the subject. Several participants commented that their interest in computers really started when their family got an internet connection. The structural resource of their expert relative provided them with the opportunity to develop their skills, understanding and interest to a depth greater than would otherwise have been likely.

Having a relative employed in IT would help generate understanding and perhaps enthusiasm. However this would depend on the nature of their relative's job; what they convey about it and what they chose to explore in their home environment. It is perfectly possible that computers can be assembled and sold with little understanding of the nature of the software that runs on them; it is perfectly possible that someone can have the job title 'IT consultant' and yet not be able to write even the simplest of programs; it is perfectly possible to be an 'IT developer' and yet only understand about configuring pre-written systems. Even if these relatives' expertise were limited in this way, they could still have had a powerful role in enthusing their kin. By having access to a knowledgeable relative these young people were given the opportunity to make a more informed career choice: their agency in this matter was significantly enhanced.

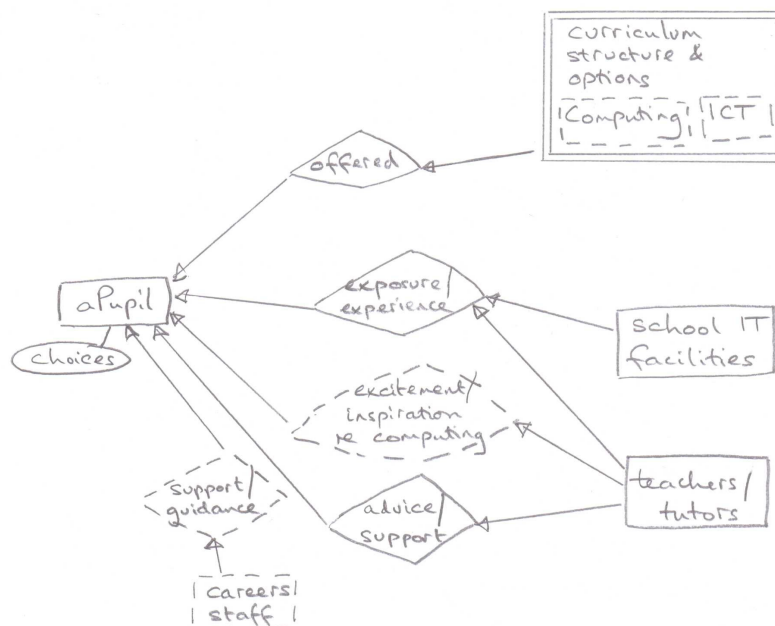


Figure 6-5: The role of school in choosing a computer course

6.3 The Role of School

School education occupies much of a child's life. As well as imparting knowledge, schooling helps with the shaping of a child's character and the development of their interests, expectations and aspirations.

Along with their home life schooling is profoundly significant in the life choices made by a young person. In considering the role of the school in whether pupils choose to study computing in HE, the key actors identified were: careers staff, teachers, school IT facilities and the curriculum being offered. Peers might be significant for some pupils too, although they were not raised in the current research. These associations can be represented in an AAD (Figure 6-5). However before considering the detail of these relationships, it is first necessary to consider issues related to progression through school: a process which can be seen as a conveyor belt.

6.3.1 The Education Conveyor Belt

For pupils to consider applying for a computing course in HE they first need to remain in education until age 18. The educational system, and society more generally, exerts pressure on young people to stay on at school. In addition, HE entrance has become normalised and it is now the expectation of, and for, all reasonably academic youngsters (Stevenson and Lang 2010). Whilst this must apply across disciplines, the consequences seem particularly significant for computing.

Schooling is sometimes seen as a 'pipeline' (Cooper 2011, NESTA 2011) in which children enter at one end and are disgorged at the other end. But the analogy is not entirely apt. Material which enters a pipe reaches its destination. However schooling is not like that; children leave their formal education at various times. Sometimes education is likened to a 'leaky pipeline', in recognition of multiple exits (Crick 2013). However that analogy is not quite apposite either. A pipe transports material from one location to another but the nature of that material is not modified in transit. However education aims to change people as they progress and a conveyor belt may be a better analogy (Figure 6-6).



Figure 6-6: The Education Conveyor Belt

The analogy of a conveyor reflects the fact that you can stand on it and just get taken along, being processed and changed. No thought is needed, although if you wobble badly-enough you might tumble off. The conveyor analogy has previously been used in an educational context by Robinson (2010) although he was considering the non-personalised character of much education, where all pupils in each batch are treated the same. That is not relevant here.

The educational conveyor transports many pupils through the school system into university. A few will have left education at age 16 and some at 18. Some will continue their education at FE colleges, rather than university. A few people will rejoin the system of conveyors later, as mature students. Indeed university could be seen as just another part of this belt system. Pupils usually have a choice about whether to leave or to apply to stay, although for many staying in education would mean taking a lower-level or vocational course, rather than pursuing an academic route. Some pupils will have given significant thought to

their decision to stay in, or leave, education. However, for some the pressures and expectations are such that they progress through education, on the conveyor, and find themselves one day at university. They have not actively chosen to remain in education: the system pulled them on.

The power exerted by the structural expectation for many, of university entrance being seen as the norm, must not be underestimated. Very few participants in this study suggested that they had considered not applying for university (although this topic was generally not explicitly explored). Of course, participants were largely recruited from visitors to university Open Days and enrolled students: they were mostly people who had already passed the stage where they would have been taking such a decision.

Two participants, at least, did consider not going and ultimately both decided not to take up confirmed offers of places.

"When I began looking I wasn't very keen on going to university but as I kept looking I was warming to the idea of going. Now... I have gone off of the idea of university a bit" (Emma-3).

Having not taken A-level Computing Emma was anxious about her ability to cope with a university computing course and she really did not want to leave university without a degree and yet have a large debt. She commented that 'everyone' had reacted to the increased fee level and wondered if they should still go to university.

Jason also eventually decided not to actually enrol on his Ethical Hacking course. Jason's main concern was also about the level of debt he would accrue. He realised that, despite current unemployment levels, jobs are still available, but he was not sure he would manage to get one. He secured an engineering apprenticeship instead.

Both Jason and Emma secured confirmed places on their chosen courses, despite gaining significantly poorer A-levels than their conditional offers. Certainly for Emma (and perhaps for Jason) her weak A-level results dented her confidence in her ability to gain a degree, rather than seeing her place as being a 'fortunate' opportunity. Both Emma and Jason would have been first-generation

university students. Without the cultural capital of parents' experience of higher education they may have been less aware of the benefits which a degree can bring. This is in line with the link noted by Noble and Davies (2009) between HE participation rates, parental occupation and their HE experience. Emma and Jason have both chosen to step off the academic education conveyor.

Thus the structural forces coming into play on the academic route from secondary education into university can be viewed as a constrained conveyor belt with some pupils leaving at a small number of choice points along its path. Many pupils seem to have paid little explicit consideration as to whether university education is the route they personally wish to pursue. However it is not just continuing in education which receives little consideration: pupils pass through their schooling having needed to make only limited choices about their programme of study either. The structural systems in which they are schooled require them to exercise little agency.

6.3.2 Options

School pupils need to choose the subjects to study for GCSE and then A-levels, or maybe vocational alternatives. However schools do not allow pupils a free choice of subjects. Driven by issues of timetabling and also the need to ensure that pupils have a balanced programme of study which fits the requirements of the National Curriculum, schools impose restrictions, providing pupils with structured option choices. Pupils' agency in subject choice is significantly constrained by the structural forces of the National Curriculum and school policy. This is particularly powerful for GCSEs with participants often reporting that they had very little choice. At A-level choices tended to be freer, but were still constrained. Emma described her choices as:

"You can choose from quite a lot of subjects but only one from that box"
(Emma-1#284).

The restricted nature of school option choices has had the effect of leading to many pupils making course choices with very little consideration of the consequences. They have had little agency or experience in this regard and may fail to appreciate the possible implications of a poor decision.

A few pupils have definite career plans in mind and are able to base their option choices around those plans and some were aware of the significance of their choices and made them thoughtfully:

"I didn't know what I wanted to do at university so I wanted to keep my options open" (Emma-1#286).

"Once I knew that I wanted to do ICT at university, I then went on some of the websites for some universities and I figured out what I needed to get" (Charlie-1#176).

If they have no specific career direction in mind, pupils will often just consider what they enjoy or are good at (for instance, Dave, Rebel and Charlie).

"I went with my best grades, what I enjoyed and me being the sort of person I am and what I tend to enjoy" (Dave-1#413).

"I've always had computers as a hobby. I enjoyed it" (Pete-1#12).

Some have become accustomed to making 'gut-reaction' choices. Charlie recognised that achieving good GCSE grades was important:

"I think even if I didn't enjoy some of the subjects I think I would have taken them just because I thought I was going to do better in it than I was [in] something I enjoyed" (Charlie-1#156).

Thus we have an educational conveyor which leads many pupils to progress through the school system without a great deal of thought about why they are there and without having given much consideration to any alternatives. Coupled with their experience of having had to make educational choices which are limited in scope and often in consequence, many pupils reach the stage of choosing their university course with very little experience of having had to make significant educational choices.

When they are faced with selecting a subject to apply for at University many pupils are inclined to take a naïve approach. Like Dave and Sunny, having made their constrained choices of GCSEs and A-levels on the basis of enjoyment or success they are inclined to adopt a similar approach to choosing a degree topic. They considered their interest in the subject but not the implications and consequences of their choice. Indeed a few students (such as Innocent) cannot be regarded as exercising much agency in the matter.

"I don't really find the technology that interesting. It's just an extension of reading and writing and actually doing something" (Innocent-1#81).

Nick chose computing solely in order to be able to study in the UK: *"to be honest a lot of my friends were studying in the UK"* (Nick-1#8) and Avtar and Innocent applied to their local university only, without even visiting it. Such students go where the structuring forces of their previous achievements, and other inputs, take them and 'go with the flow'. They can be seen as behaving like Pooh-sticks, being taken wherever the current goes. This will be explored later (§6.6.6). The lack of agency in course choice must be the behaviour of many pupils, across many disciplines. But for students in the area of computing, who, as will be discussed next, often misunderstand the nature and substance of computing, this tactic can prove particularly problematic.

6.4 Routes to Exposure to Computing

As will be illustrated, many, indeed possibly most, school pupils have a limited or misconceived understanding of what studying computing is about and therefore what a computing degree course might really entail. If the course had a name which pupils realised they did not understand – something maybe whose title was not part of standard English usage, such as Informatics, Logistics or Dietetics – then, before they considered applying, they would probably investigate it fully. But 'computing' is well used as a lay term, just implying 'using a PC (personal computer)'. However a University computing degree is not about how to use a computer. The content of such a degree is not only intellectually much more rigorous than this but it is of a different nature too (§2.4) and requires skills and aptitudes not necessary to simply 'use a PC'. Additionally it will often cover technologies other than just those which apply to PCs.

As will be explored (Chapter 7), many students are surprised by the content of their course. As an extreme example, Michael recounted how a fellow student had said he was expecting nothing much more than to be able to spend all day on Facebook. His peer was clearly expressing discomfort at his course's content, even if he or Michael were perhaps misrepresenting his expectations for

dramatic effect. It is more likely that he did not know what he was expecting but was unwilling or embarrassed to say so. Michael commented that this student left the course after the first few weeks.

There are a number of routes by which pupils might gain a better understanding of computing: most often it is through friends or family (§6.2.2), but sometimes it is through school.

6.4.1 Exposure in school

Currently, in England most school pupils do not encounter a subject called Computing (or Computer Science) (§2.3). However this research shows a number of mechanisms by which a pupil might be exposed to technical computing through school. The confusion between computing and ICT, mentioned but barely evidenced in the literature (§2.7), will also be explored. Careers advice does not appear to take much role in making pupils aware of the nature of computing and will be explored later, within course choice (§6.6).

Computing activities

A few pupils do have the opportunity to study Computing and, where available, it is usually through the qualification option structure (§6.3.2). The changes planned for the National Curriculum, which will affect this, are discussed later (Chapter 9).

Various learning activities can form a route by which pupils come to understand the nature of computing. There can sometimes be an excitement for, or inspiration about, computing engendered by particular teachers or lessons which can spark off, or cultivate, an interest. Scarab came to enjoy Computing generally through his A-level studies. Dave spoke with real excitement about writing program code to drive a robot around his school. Notably this was at primary school. He was much less excited by a similar activity at secondary school where the robot was virtual and he was controlling it around a course on a computer screen. It is possible that the similarity of the task detracted from the latter, but Dave articulated it in terms of the physical engagement with the activity and the age of his exposure. I suspect he also relished having lessons where it

was required that pupils behave divergently, breaking the norms of school life and roam the corridors during lesson-time. It was this experience which triggered his interest in computing.

A few pupils (such as Avtar and Jessica) had ICT teachers who delivered a version of the curriculum which exposed them to computing topics such as programming, computer control or database design. These topics can be delivered under the umbrella of ICT but can likewise be avoided by teachers who, for whatever reason, choose not to deliver them. Thus most pupils do not experience this 'enhanced' ICT curriculum (§1.5).

An interest in computing topics can be engendered in other subject lessons too. Indeed ICT content is often delivered through other subjects. Neither of Dave's robot programming experiences was in computing classes, but probably in Mathematics. Dave is unlikely to have appreciated at the time that he was learning about programming and algorithms. He was just having fun controlling robots and needed subsequent experiences to appreciate that the subject he had enjoyed was Computing.

So, teachers can enthuse pupils to computing through practical activities. But this is evidently not a regular occurrence. Most pupils do not have the opportunity to be enthused by any of the technical or intellectual challenges underpinning computing. They are not exposed to any form of technical computing in school, through Computing classes, their Mathematics or ICT curriculum, a computing club or any other potential route. Hence the 'excitement about computing' relationship between a pupil and teachers, is a 'fire' relationship (Figure 6-5). It is rarely present.

Confusion with ICT

All school pupils in England study ICT, to some level. Whilst it has a very mixed reputation (§2.3), quite a number of pupils thoroughly enjoy it. If they have become accustomed to making educational choices with little investigation (§6.3.2) or advice (§6.6.1), then they are likely to adopt this strategy again in choosing a degree subject. If they have enjoyed their previous study of ICT it

would be natural for them to look for a degree in ICT and, barely finding such a title, to deduce that at university ICT is usually called Computing (or Computer Science).

As a result of not being exposed to computing in schools, many participants simply treat the subjects of 'computing' and 'ICT' as synonymous. This conflation was mentioned earlier (§2.7 and §5.2.1). For example:

"They [friends] said ICT is probably too general, too wide a setup; and others because they just thought it was too complex really. They said: "Ah computing: I can't do that" " (Omar-1#637).

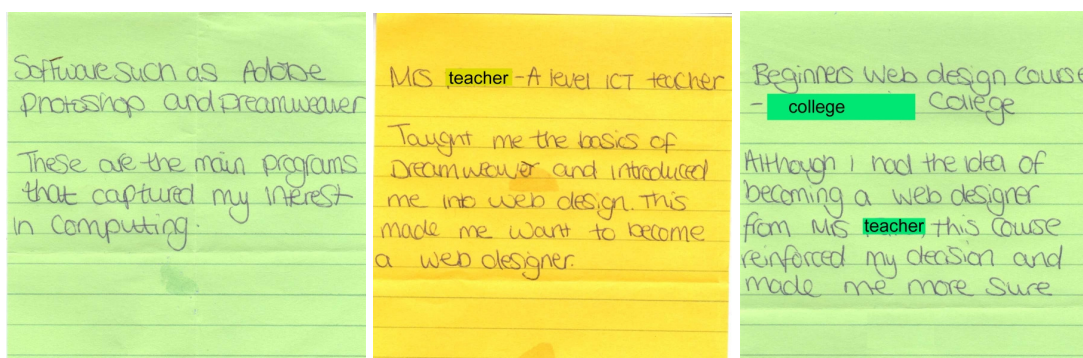


Figure 6-7: Extracts from Jessica's pyramid of careers influences

Jessica really enjoyed her ICT A-level work, particularly the web design and development aspects and sees that as a preferred career direction (Figure 6-7). She has applied for a technical computing course, albeit Multimedia Computing. She will find web design there but it is not evident that she understands that computing courses are about the creation of computing-based systems and processes. She kept referring back to the motivation of her positive experiences of ICT to such an extent that it seems she is not clear that computing differs from ICT.

Over years of practice, anecdotes and comments suggest that a minority of computing students are expecting an extension of their school ICT (§2.4). Several participants (such as Martin and Michael) mentioned their experiences of

talking to fellow students who had expectations such as this. This conflation has been widely reported previously (§2.7).

These students have potentially been misguided by the lack of a universal understanding of the term 'computing'. They operated using an interpretive scheme which included an understanding of the term which differs from usage common in universities. The communicative element in the social structure has led them to make a poorly informed choice: their agency was poorly guided. This is not to say that their choice is necessarily academically problematic or subsequently regretted: some will adjust to their course and thrive.

The second main consequence of this confusion is that pupils do not know the challenges and enjoyment that computing can bring. As suggested by Mitchell (2005), they may not see the point in taking their study of the area any further (§2.7). Indeed, as reported by Martin and Victoria, they may even feel they already know it all, in that they believe that they can readily explore new facilities and software by themselves, on an 'as needs' basis.

Thus the lack of exposure to computing in schools is misleading some students about the content of a computing course which impedes their agency to make an informed choice. This supports previous work (for example, Mitchell 2005 and Cutts *et al.* 2007) that many pupils simply do not know what CS is about (§2.6.1). For a few, this means they may make a choice they come to regret. For others it must mean that they reject an option which would suit them well. The potential implications of this for student engagement are discussed in the next chapter. Since computing is currently not offered in most schools pre-age 16 it is interesting to consider what leads those very few pupils who do so, to choose to take A-level Computing, where it is available. What was their route there?

Why take Computing A-level?

It is interesting that a surprisingly large number of research participants had studied A-level Computing. For a subject studied by under 4,000 students nationally each year, and at that time not available as a GCSE, it is notable that four of the 13 longitudinal participants had studied A-level Computing. (Seven of

the others had taken ICT.) Of course, part of the reason for this disproportionate representation is that Computing A-level is largely taken by pupils who are, by whatever route, already computing enthusiasts and are therefore by age 16 already very likely to apply for a computing degree later.

Of the four who took this A-level, two were largely influenced through their school. Dave, as already described, was enthused by programming robots in primary school and Scarab's school offered both ICT and Computing, providing a careful explanation of the difference. The other two were influenced by their family. Rustyrose saw his older sister programming Flash animations and wanted to be able to do similar. Jason's father works in IT support and he influenced Jason, leading him to take this A-level. The influences on their course choice were thus a mixture of school and family. Of course, for these students to be able to take this, their school needed to be amongst the few which offered it.

6.4.2 Other routes to exposure to the subject

Whilst most participants either recount the importance of family experiences and self teaching or, for a few, of exposure to computing at school, there are other routes which can lead to an understanding of what the subject is about.

Nationally there are many initiatives to achieve this (§2.4.2). Victoria had the opportunity to attend a taster day for students from less-advantaged areas at which Google set them some challenges. Whilst she chose to attend this since she was already interested in computing she recounts how she enjoyed the activities set and felt she would be quite good at such things: attending the event confirmed her thinking.

A few participants (for example, as Alex and Carl) spoke about gaining an understanding of the nature of their computing courses from university Open Days and websites. They spoke of reading the descriptions of courses and modules and of using this to develop their understanding of what the subject is about. Alex was the only participant who made any comment which acknowledged that a Computer Science course at one university could be very different from that at another. It is likely that most universities believe that their course descriptions on their website are used primarily to promote their course to

prospective applicants. A few universities do recognise the need to inform applicants about the nature of the subject generally (Queen Mary, University of London being a prime example). Applicants need information to choose their subject first and then information to allow them to choose the university where they wish to study. It is through processes such as these that some students gain an understanding of the nature of computing.

The potential situations in which a student may find themselves can be viewed as a matrix (Figure 6-8). If pupils understand the nature of a computing degree then they can make an informed choice about whether to apply for it or not. Of course, an informed choice does not guarantee a positive outcome since that will depend on many other factors, such as ability and motivation, but at least they chose based on understanding.

		Interested in or enrolled on a computing course	
		Yes	No
Understands the nature of content eg CS v ICT	uninformed choice No:	dissatisfied unhappy may come to enjoy	rejects something they do not really understand
	informed choice Yes:	informed selection okay	informed rejection

Figure 6-8: Choice matrix

If pupils remain uninformed then their choices can be misguided. If they decide not to apply then some of those students will be rejecting a course which they might enjoy and be well-suited to. However if a misinformed student enrolls on a computing degree the outcome is uncertain. They may come to enjoy it and

thrive. But for some the experience will be unhappy and they may become dissatisfied and disgruntled. Potential student dissatisfaction is considered in the next chapter and broader possible consequences for recruitment later, in Chapter 8. Thus there are a number of ways in which a pupil may come to understand the nature of computing but this does not address what an applicant may expect from it.

6.5 Expectations

A number of issues emerged concerning what students are looking for or expect from a computing course. Some are generic, applying to most subjects and will not be discussed, such as those participants who see a degree as an opportunity to explore and learn about new areas. Specific topics of content are mostly not covered either since these were only discussed when participants raised them as being surprising or unexpected.

6.5.1 The unexpected?

The lack of prior investigation of course content, even to the module-title level, means that many students can be surprised by some elements of their course. Of course, even if they have read the module list there is no guarantee they interpret titles in the way the course designers intended. Some students found their course to be broader than they expected:

"There's a lot more opportunity. There are a lot more areas and subjects to learn" (Carl-2#116).

Carl undertook significant pre-application investigation of the course, so the surprise he is expressing probably occurred then.

Post-enrolment, Omar was surprised to be studying Usability:

"And then you have usability [...] because when I was doing computing I thought: 'well it's going to be about computers and the most important thing is computers and programming', and then our lecturer said: 'the most important thing about computers is people', and then for me, that drew my attention" (Omar-2#82).

And Arthur was surprised by several elements:

"Some of the modules that I've done in computing, it was completely different to what I think [sic] it would be. I mean things such as programming and software systems, I knew I'd be doing something along those lines. But then on the other hand, usability that was completely [unexpected]... and Maths [...] and what else – Computer Architecture [...] where we'd go through past history of [operating systems] and binary and just little things [...] It wasn't bad. It was quite interesting. I didn't think we'd be taught something like that at Computing" (Arthur-1#161).

Arthur had been unable to secure a place on his first choice course and needed to choose another. He had had experience with some significant aspects of computing, such as programming and server management, but this dialogue makes it evident that his course investigation must have been minimal. These findings align with the anecdotal reports from Boyle, Carter and Clark (2002) that computing students are often surprised by aspects of their curriculum (§2.6.1). The potential impact of this on student engagement is discussed in the next chapter and the implications for action for stakeholders in Chapter 9.

6.5.2 Programming content

A few students (such as Ez and Richard), new to studying computing, come to it not being aware of the nature of programming – of its precision and pernickety-ness. If they have not considered this in their course selection then it can come as a surprise, one which, as much previous work shows (§2.8), can prove to be a significant barrier to progress.

After listening to presentations at university Open Days, Rebel decided that she did not want a Computer Science course as it would be too programming-focussed for her interests. She decided she wanted a course which was more slanted towards electronics and device design. Justin was looking for a balance of content.

"I was thinking: 'what course should I choose?' I didn't want it to be too creative; I didn't want it to be too, um, raw in terms of programming. So that's why I chose MultiMedia Computing" (Justin-1#49).

Farouk, a Software Engineering student, unsurprisingly was clear that he had wanted a course which focussed on programming:

"Basically I applied for computer science as well and I looked at the modules and they looked similar. But at the end they got a bit separated, so yes, I looked at the modules and I decided software engineering, maybe, might suit me" (Farouk-2#242).

Many applicants, including Charlie, Ez, Jessica, Neil, Pete and Richard, have had no prior experience of programming and some may be unaware of its character. Others (such as Rebel) have had some exposure to it, are aware of this character and do not want to do more. Some (like Farouk and Teken) will have thrived on their exposure and are keen for more. Some applicants (such as John) have done some programming work using some simplified educational programming environment but not tried programming using any professional language. They may have created webpages in HTML (which they might think of as programming) or written a small application in VisualBasic or, increasingly likely, created an app for a mobile device using, say, AppInventor. These applicants may have enjoyed their experiences but, whilst such background is helpful, it can mislead the student as to the core nature of serious, professional programming. Some learner programming environments support the coder to such a degree that the precision of programming is not evident. They may guide the programmer through the syntactic options; limit, or not expose, the management of data and may provide little experience of algorithm design. These are core elements of professional programming and aspects which frequently cause difficulties (§2.8).

Thus applicants have a diverse range of prior exposure, aptitudes and interests in programming. Some want a computing course but do not want it to contain any programming; some feel reasonably comfortable about programming but may come to feel negatively about it when teaching commences; some want their course to focus, maybe entirely, on programming (McGettrick *et al.* 2005) and some others, who have had no contact with programming, may apply having no opinion on the matter. Many applicants (including Justin and Rebel) are well aware of the significance of programming content ahead of applying. Indeed it has been observed in practice that a number of visitors to Open Days are very keen to discuss this aspect of the various courses. That some visitors are hoping to find a computing course which does not contain any programming at

all, is an indication of a difference in understanding of the nature of the discipline. However it appears that most HEIs, and much of the IT industry, expect graduates of almost all computing degrees to have some programming competence.

If applicants have had some 'useful' programming experience, such that they understand its character, then the course choices they make are presumably more likely to fit with their interests and aptitudes. However if they either have no programming experience or their experience is 'misleading', then choosing a course which relies heavily on programming content is unsafe and 'dangerous' and, as will be discussed (Chapter 7), can prove to be problematic. These situations are modelled in Figure 6-9.

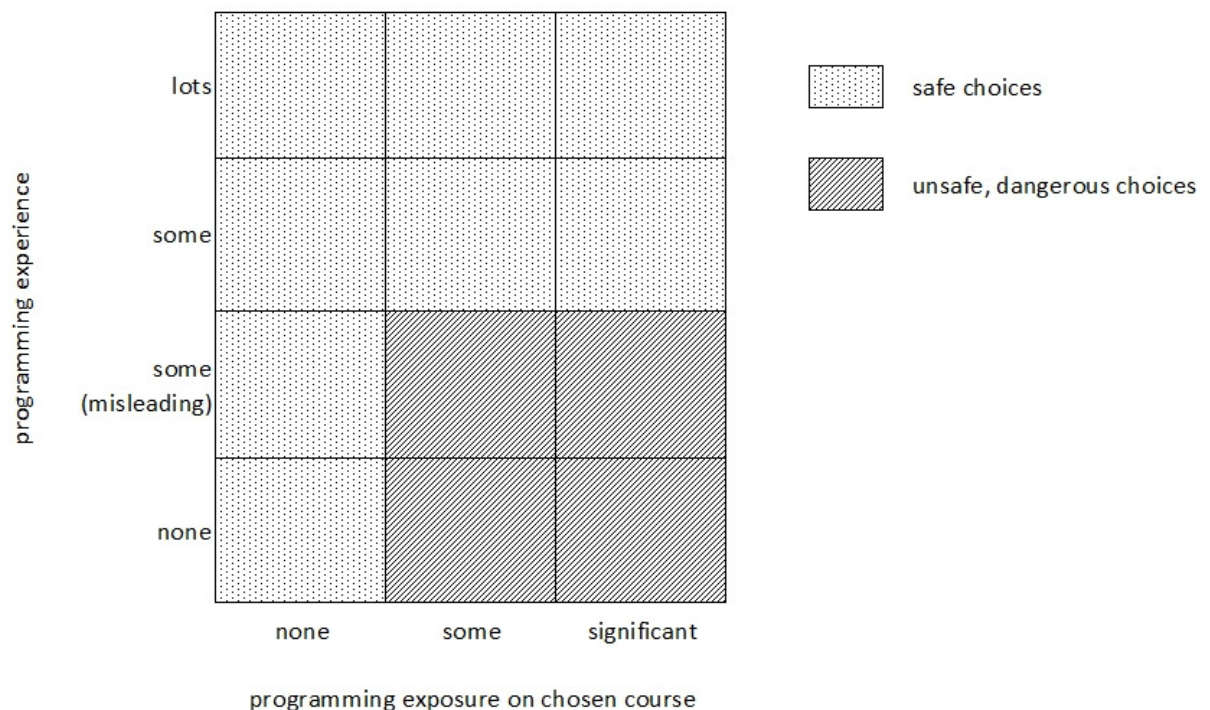


Figure 6-9: Relationship with programming

This Relationship model, of course, links to the Choice Matrix model (Figure 6-8) which considered whether students might make an informed course choice, based on whether they understand the nature of computing. Their

understanding and experience of programming can be one aspect of that awareness, although there are many other topics exposure to which might help them appreciate the nature of computing, such as logic, hardware design or database development.

6.5.3 ***"You've got to keep up with everything"***

Computing, as a subject, changes very fast. Whilst the fundamental principles are enduring the technologies, hardware and software all change rapidly. One can very quickly cease to be up-to-date about the particular. Chris was very concerned about this.

"In 5 years that's... that's like so much in computing... You're going to have lost out on the game. You've got to keep up with everything which is coming out new: stay up-to-date" (Chris-1#220).

At the same focus group meeting, Justin made a similar point:

"Even just like [after] one year you're really behind. I mean look at mobile applications. In the past like 5 years the industry's grown like 200%. Imagine if there was no modules and stuff in like mobile applications. It makes... you want to feel like the course is current with technology: [...] as technology's growing the modules are conforming to that technology" (Justin-1#244).

Quite understandably, these participants wanted to be sure that they would be employable when they graduate and saw it as a requirement of their course to ensure their skills were current. In considering the pace of change in computing, McGettrick *et al.* (2005:10) recognised that new graduates should have: *"high levels of appropriate and useful skills"*, although they did not consider how those skills might be identified nor whether this is what universities currently deliver. They also identified that: *"graduates need to recognize that the currency and quality of their skills, and their competency levels, will be significant determinants of [their] success"* (*ibid.*:10). Justin and Chris are well aware of this. Students see in job advertisements that many employers are looking for expertise in the very latest technologies. They recognise that this is hard to achieve but are still hoping – expecting – that their university course can guide them to that end point. It is not unreasonable to expect that a university computing degree

prepares students for computing employment. However the reality can be somewhat different.

Some employers expect new graduates to be skilled in the specific technologies that they use in their organisation: for recruits immediately to be useful, productive employees. As a typical example, a recent advertisement for an unpaid internship, circulated to students, specified:

"a fairly good working knowledge of XHTML, CSS and in particular PHP and Object Orientated programming – some experience with WordPress is also required. We are not looking for creative designers for this role, just coders please."

Coventry University does not teach PHP programming nor do students use WordPress to develop websites but other commercially relevant software. Very few Coventry students would satisfy these requirements. Whilst such specificity may not be surprising for a small company, it is not atypical. This tension between employers' desires and course design and the implications for stakeholders are discussed later (Chapter 9).

Having considered how, or indeed whether, pupils come to understand the nature of computing and some of the qualities they expect from a computing course it is now necessary to consider the influences relating to their selection of computing for HE study and potentially as a career area.

6.6 Course and Career Selection

There are many routes which may lead a pupil to decide that they want to pursue a computing degree. However, sometimes the structural limitations of an applicant's situation can severely restrict their choice. Three students (Arthur, Avtar and Farouk) were recent immigrants to the UK and were using their computing background to give them a route into UK HE. None of them would have chosen computing if their education had been less disrupted and aligned better with the UK educational system. Other mechanisms which lead to course choice decisions were discussed previously since, of course, the same processes which lead to pupils understanding what computing is about can also lead them to want to pursue it. However some additional areas merit discussion.

6.6.1 Careers advice

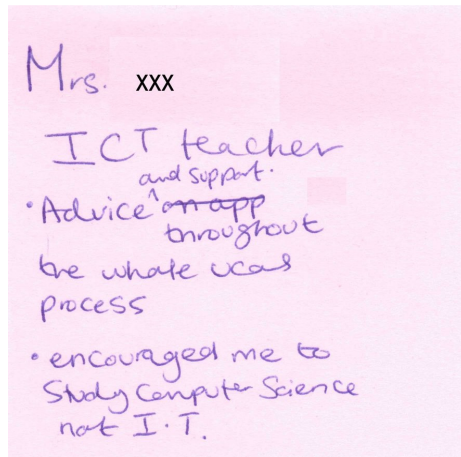


Figure 6-10: Extract from Victoria's pyramid of careers influences

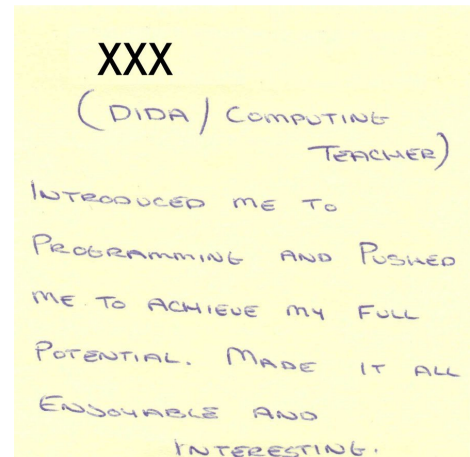


Figure 6-11: Extract from Dave's pyramid of careers influence

In line with findings by Preston and Mellors-Bourne (2007), explicit careers advice was seldom significant. Teachers sometimes provided useful guidance, such as for Victoria (Figure 6-10) and Dave (Figure 6-11). However very few participants mentioned careers advice *per se* as being influential. Martin mentioned a careers advisor at college, but this came at the very bottom of his pyramid of influences. Jay referred to attending a careers fair although it also was low in his pyramid. However it is very likely that he did not feel any need for advice since his father works in IT, an uncle is a CS university lecturer and he has friends who have read CS degrees. Neil put a Connexions careers officer as being of mid-significance, as did Scarab of a career's advisor (Figure 6-12).

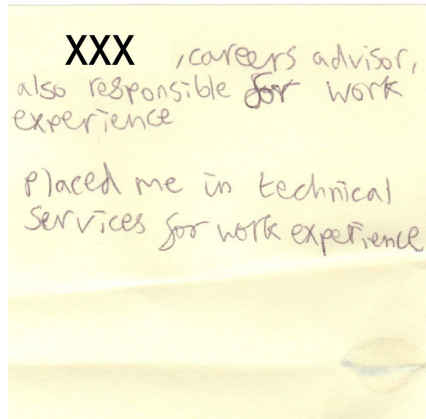


Figure 6-12: Extract from Scarab's pyramid of careers influences

Overall though, careers staff and services seem to have been of little significance to most participants. Both a relationship with these specialist staff and their support and guidance, need to be viewed as being 'fire' – sometimes present and sometimes not. The main implication of this, as indicated in Figure 6-5, is that careers services cannot be seen as a reliable mechanism by which pupils receive careers advice. As discussed later (Chapter 8), schools' careers advice has recently been restructured.

Whilst it is possible that pupils across the disciplines would view their experience of career advice in a similar manner, the inconsistent nomenclature must be problematic for many careers advisors. The Royal Society (2012) recognised that careers advice is one area which would benefit from the consistent naming of subjects in this discipline. The implications for careers advice are discussed in Chapters 8 and 9.

6.6.2 The role of universities regarding choice

After the family and the school, this research suggests that universities are the other prime influence on pupils' course choices. The range of influences of universities can be represented as in Figure 6-13.

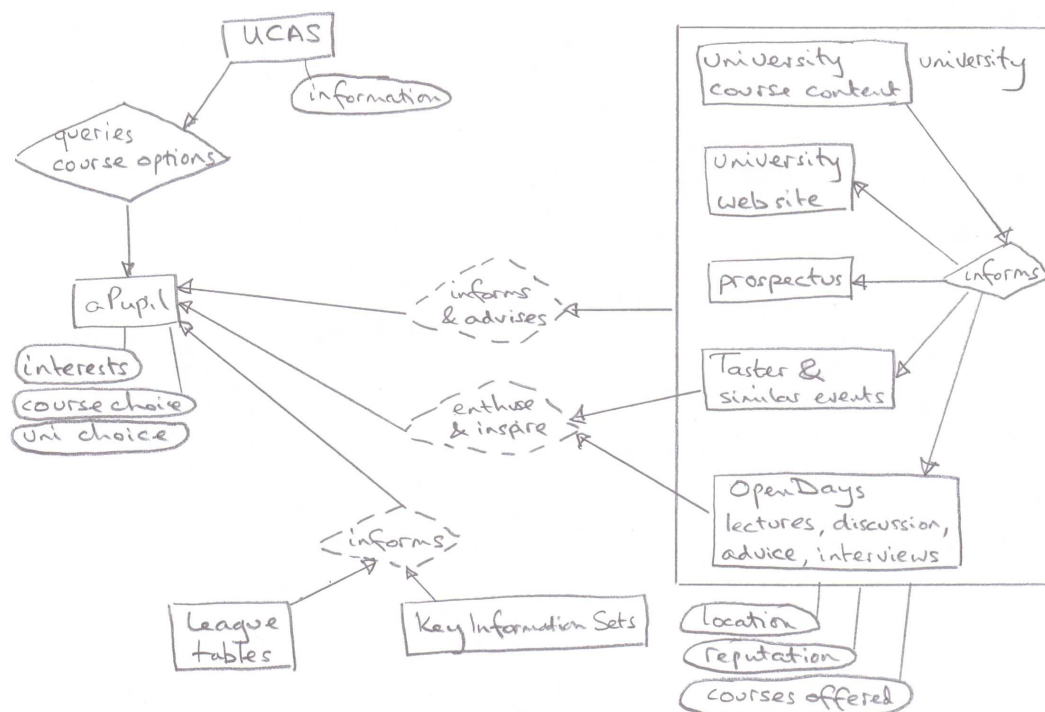


Figure 6-13: Role of universities in students' course choice

UCAS provides the mechanism for applying for university but it is also sometimes used to determine course availability. Charlie reported using it to search for degrees entitled 'Information and Communications Technology (ICT)' and, after identifying little, ended up applying for computing courses.

Universities themselves are, of course, an important source of information and advice. Some of the ways employed have already been discussed (§6.4.2). As will be established (§6.6.3), a minority of applicants make very little use of universities or any other source of guidance. Thus, whilst universities have a significant role in providing information to very many applicants, for others it is absent. In ANT terms, this is a 'fire' association (Figure 6-13).

A government initiative has led to the development of Key Information Sets, "*designed to meet the information needs of prospective students*" (HEFCE 2012). These data, along with a range of university 'league tables', can allow students to make their choices based on a range of performance indicators

although, as Yorke and Longen (2008:46) point out, they can "*attract the unwary into the marsh of misdirected choice*". Only one participant mentioned using any performance statistics: Alex was guided by 'student satisfaction' ratings. Several participants in this study did not seem to know that universities are very different in nature and based their decisions on their visits. As has been mentioned (§6.2.1), it is likely that pupils with more family cultural capital would be more aware of such distinctions. However the background of many participants may have denied them the awareness from which to make fully informed university selections.

These tensions are probably similar across the disciplines. Very few students gave any indication that they realised that courses of the same title may differ, widely. However, for computing courses this is not an inconsequential matter (§2.4). For example, if students unwittingly enrol on a CS course which is highly theoretical in nature, they may be surprised and disappointed by their choice. A participant in the preliminary study, an academic from a Russell Group university, reported this as being quite a frequent student experience. The implications for action for stakeholders are explored in Chapter 9. Due to their much higher entry requirements, very few of the participants in the current study will have explored the options at these 'traditional' universities, although Alex did.

"It was then [at a Russell Group university visit] that I realised that perhaps that wasn't what I wanted. But then I had another lecture in [a 'red-brick' university] and then it seemed exactly what I thought Computer Science was going to be" (Alex-3#34).

However, of course, Alex eventually decided to study mathematics rather than computing (§6.2.2).

6.6.3 Researched course details

Most participants were really very vague about what they expected from their course. They had done very little investigation. Some participants reported looking at the list of modules on their course, for example Scarab and Joey, but very few reported investigating module content. In a conversation half-way through his first year, Carl said:

"I think I knew that I wanted to do this, because I had sort of researched the modules of the course. [...] I hadn't had that much experience, but I knew that I wanted to do it. And I kind of went: "Right I'm going to do this. And I know I can do this because I'm a nerd with computers, but I don't know that much about them yet and I want to." " (Carl-2#154).

For Carl as a mature student, returning to full-time education was a very significant decision. It is understandable that he would want to delve into the course information both to allay his anxieties about his ability to cope and to confirm that this was what he wanted to do. Other participants' lack of engagement with the detailed content of courses is more surprising but there is no evident reason why computing should differ from other disciplines. The implications for the availability of information are discussed in Chapter 9.

6.6.4 Levels of choice

For many participants the breadth or specialism of the course or the freedom to choose options was an important feature influencing their choice. A few participants have a very clear career direction in mind and are keen to apply for a course with that focus, perhaps Ethical Hacking, Games Technology or Software Engineering. However sometimes they are seeking breadth, so they have access to a wide range of computing jobs. Matthew, enrolled on the broadest course available, Computing, said:

"It's really broad, so it's really good for me to develop some sort of skills or explore it more in a broad course, rather than just programming or something like that" (Matthew-1#19).

Many participants reported, positively, on their course offering a range of options, allowing them to match their studies to their interests. Justin, a student on Multimedia Computing, was very keen to have choice within his course.

"I like loads of options" (Justin-1#321).

Dee, a Games student, welcomed the flexibility at Coventry of having a 'common first year' which allows students to swap to a closely related course.

"In year one everyone does the same thing and if someone notices that they want something different, they're fit to evolve in that direction in year two" (Dee-1#202).

For him, this option reduced the pressure of needing to be sure about the precise course he applied for initially, deferring his 'final' decision for another year and allowing him to change his mind as he learns more. Participants often commented positively about this facility.

Omar had an interesting rationale for choosing a Games course, recognising the wide range of aspects of computing it must cover:

"I always thought that computer games were almost like the height of a computer, because you have all the processes [i.e. computing techniques] engaged. You're using graphics; you're using programming; you're using usability and everything is engaged [...] Even networking is included as well" (Omar-2#70).

Later he continued:

"I actually would have essentially chosen something like Software Engineering or Ethical Hacking until my tutor from Sixth Form said: "You want to specialise, but you don't want to be too specialist in a specific area because markets do crash", and he spoke about Games Technology and when they went over it they said there are like, many branches you can go into anyway and with the programming mindset that it will give you, you can practically go into any field really" (Omar-2#200).

Omar's choice was based on guidance from his school tutor. It is not evident that he is aware of the additional demands the choice of Games will make on his mathematics and physics or that there are many aspects which Ethical Hacking students, say, would cover that he will not.

6.6.5 Credibility of computing as an academic subject

As has been described there is evidence that a lack of understanding of computing is widespread (§5.2.1), but this research also found that it is sometimes seen as lacking credibility for serious academic study, even being likened to a 'Mickey Mouse' (Guardian 2003:unpaginated) degree. This is in line with some previous work (CPHC 2006), although that work looked at pupil reports of their GCSE ICT experiences. Victoria recounted how a friend had been told by her father that computing was not worthy of study at university but could be studied in one's own time or in evening class.

"He like didn't think that it was worthy-enough as a degree. She could just build up from experience" (Victoria -1#675).

Michael described how friends referred to his study of Creative Computing as "a doss degree" (Michael-1#697). Since many people do not understand the difference between computing and ICT (§2.7, §6.4.21), and therefore imagine a computing degree to be about the use of applications, it is hardly surprising that they do not find it credible. This tension is a direct result of the different signification of the term 'computing' by people inside the profession and by the general populace. The implications of this for the presentation of computing are explored in Chapter 8 and for stakeholders in Chapter 9.

6.6.6 Pooh-sticks

Students thus choose a computing career route by a number of mechanisms. Some receive advice from family, teachers or careers services and some get guidance and information through universities or their own personal research. For a decision which can have a profound affect on subsequent career options and life opportunities what is remarkable is how very little consideration a few participants gave to their course selection. Whilst there are implications from the relatively small choices made between different sorts of computing course, the main concern is that a sizeable minority of participants simply did not investigate what HE computing courses are like.

This subject decision landscape is somewhat different from the choice as to which universities to apply to. It is obvious that studying at Aberdeen is likely to be a rather different social and cultural experience to attending Aberystwyth and that attending a university many hundreds of miles away from home would be a very different from remaining at home and studying locally. These are the choices which seem to dominate the selection process for many.



Figure 6-14: Pooh-sticks

As already briefly mentioned (§6.3.2), this research found that quite a few students behave like Pooh-sticks. They pay little attention to their subject choice but, like the sticks in A.A. Milne's famous game (Figure 6-14), they simply get taken where the current goes.

"Some students are like 'Pooh-Sticks' and drift with the current, just bouncing off the banks but not being pro-active in any way" (Preliminary Study academic participant A2, modern university).

A sizeable minority of students do not exercise any agentic behaviour but go along with the structuring forces around them. Once they have chosen their subject for their application they then seem to assume they know, at least roughly, what their course will be about. A few applicants just do not see course choice as a significant issue.

Many pupils went through their schooling having needed to make few subject choices (§6.3). The consequences of those choices were seen mostly in terms of the grades achieved and whether these were 'good-enough'. Without having needed to make significant academic choices previously, the choice of university subject is sometimes similarly treated. A minority of students progress through their degree as though they were a Pooh-stick. They get nudged into the river and get taken to some ocean. They may progress swiftly, staying in the fast current but may get trapped in an eddy, becalmed in some backwater or stranded on an island. They may eventually get released from this delay, make further progress and perhaps reach the ocean, though more slowly. However some remain in their stuck-ness and may never complete their qualification.

Those students who can be seen as Pooh-sticks are not exercising any agency. They are simply passively being taken along into and through their course. The outcome might be 'success', but it may not be. The structuring processes in their education simply take them along. These students do however have agency in the matter and usually there is nothing deterministically preventing them from taking more interest in their situation. However their weak social and cultural capital seems to either prevent them from seeing what is happening to them or not realising that if they were to pay attention they may benefit. They are comfortable-enough and thus far in their education things have worked out

'alright' for them, which for some students can be good-enough. Some of the potential consequences of such behaviour are considered in Chapter 8.

6.7 Conclusions

This chapter has illuminated a number of issues related to how students choose their courses, based around its four interwoven sub-themes. Some of these provide useful empirical evidence for previously reported assertions. The findings from this chapter are presented by its sub-themes.

The first sub-theme is that school processes provide pupils with little experience of making significant educational choices.

- The educational processes and school system just take pupils through, travelling, as it were, on an educational conveyor belt.

The second related sub-theme is that some students progress to and through university exercising very little personal agency, but 'go with the flow', as though they were a Pooh-stick.

- Some pupils pay very little consideration to their choice of degree subject. This may be a result of their experience of having needed to pay little heed to their earlier choices at school. A fully informed choice needs to consider the consequences including the detailed course content; what the alternatives are and what their choice would rule out. Whilst many students are quite careful in their choices and agency, a minority seem to behave like A.A. Milne's Pooh-sticks. This Pooh-stick-like behaviour must be a feature of some students in many disciplines. However in computing this attitude can be particularly problematic since they may drift into an unfamiliar discipline. These broader potential consequences are discussed in Chapter 8.

The third sub-theme is the range of routes by which some pupils come to understand what computing is about.

- Very many pupils, and some applicants for computing degrees, do not realise that computing is a rigorous, technical discipline, and very different in nature from typical school ICT.
- This misunderstanding is deterring some potential applicants.

These points have both been asserted previously but this study provided confirmatory evidence. Chapter 8 will consider the wider implications.

- Many pupils are not exposed to any source by which they can come to understand the nature of computing. In the UK this will change with the introduction of a revised National Curriculum, as discussed in Chapter 9.
- The route by which some pupils do gain this understanding is usually through their family or friends: it is seldom through school.

These two issues are important findings, with implications for recruitment which are discussed later, in Chapter 8.

- Some participants reported that computing is not always seen as a credible subject for degree-level study. This was unexpected but was based on misunderstandings of what a computing degree encompasses. The implications for the promotion of computing are discussed in Chapter 8.

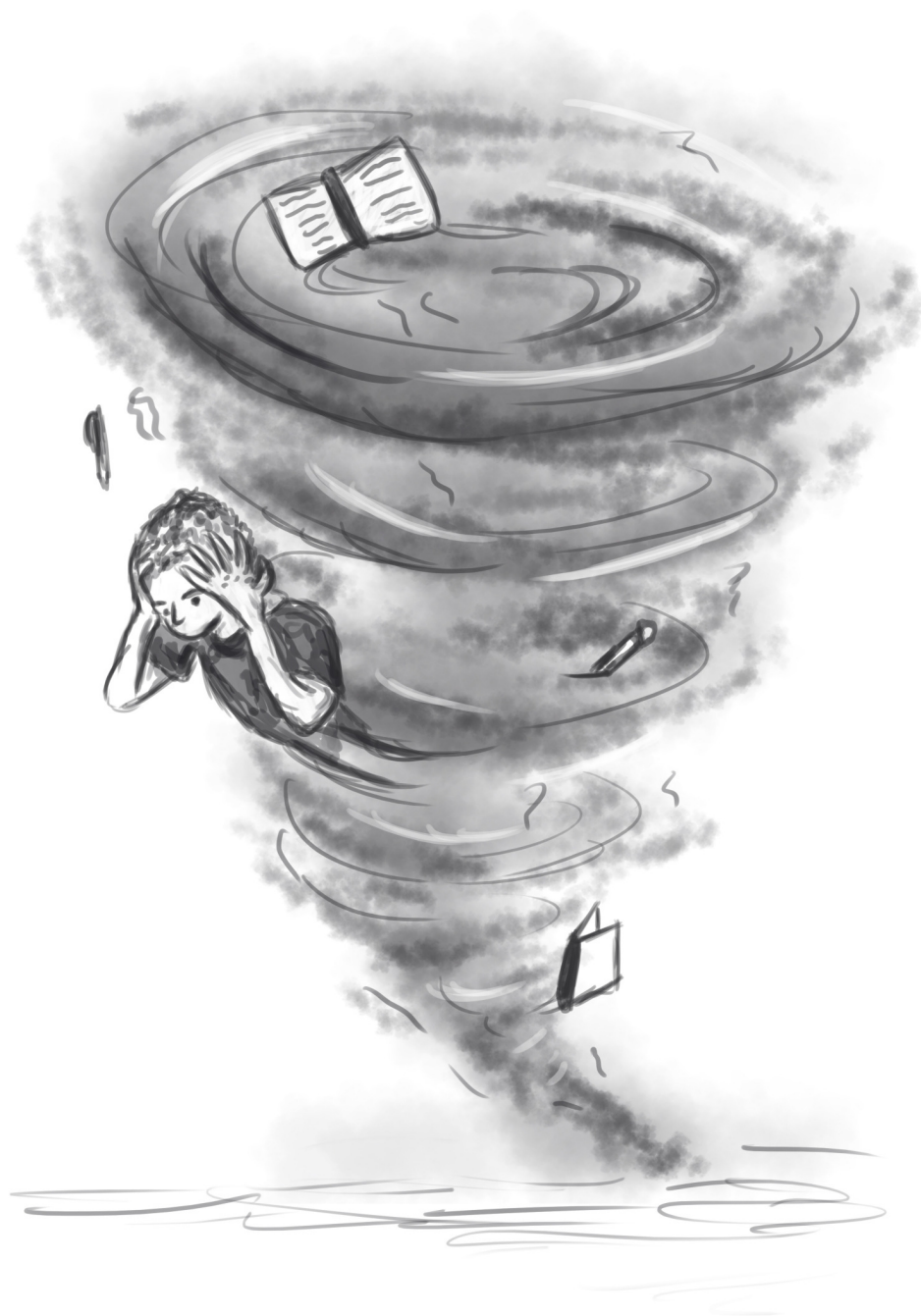
The final sub-theme relates to the misalignments which there may be between students' expectations and their courses.

- Some students are not aware of the diversity of computing degrees, may do little investigation, and therefore may enrol on an unsuitable course. This research therefore provides confirmatory evidence of the anecdotal reports

that students often express surprise at their curriculum. This is a significant finding and is discussed further, later: in Chapter 7 concerning the possible impacts on a student's studies and in Chapter 8 concerning the student choice-making process.

- Students expect their degrees to lead to employment. However individual employers' requirements can be very detailed and specific and may not align with a particular degree's curriculum. Whilst the implications of this for students have already been raised, the wider implications of this tension for employers and skills provision are discussed in Chapter 9.
- If a student is expecting their computing degree to extend their school study of ICT, there might be such a significant disconnect that it may lead to their dissatisfaction. The implications of this will be discussed in the next chapter.

7 : Engaged, or Not?



The tornado of absenteeism

7.1 Introduction

The previous chapter considered how pupils come to be in the position to consider applying for a computing course in HE and their expectations. This chapter moves on and examines some significant issues related to students' lived-in experiences of, and particularly their engagement with, their courses and explores the question:

What leads to some computing students to seem to disengage from their course? This includes the factors which affect engagement and how disengagement is represented.

Student engagement has, for some time, been an area of concern for the academic community. The term 'student engagement', and some of the sources of engagement, were examined earlier (§3.5). The aspects of interest here are those which directly relate to students' academic life – to their involvement in the teaching and learning processes. Whilst also being important, consideration does not extend to student progression or achievement. In particular, this chapter will consider the phenomena of student disengagement and how it comes to be represented.

Student disengagement is often considered to be important, since if a student is significantly disengaged then they run the risk of failing their course, if they do not simply drop-out. If they avoid these outcomes their disengagement may result in significant underperformance. As will be explored, evidence shows that just because a student is absent from class does not mean they are not studying nor that they do not care about their academic progress nor that they will inevitably fail.

The engagement of students is investigated by looking at how they see their course. Some responses to the nature of the mathematics and programming content are discussed, since these topics often cause students difficulty. The sources of student absenteeism are then explored, with attention paid to the influence of peer groups and aspects of the assessment regime.

Below are two tables. Table 7-1 shows the sources of the main data codes which were used for this chapter. Table 7-2 indicates how they, and the analytical lenses, informed the derivation of the chapters' sub-themes.

This chapter primarily looks at issues related to (dis-)engagement in computing students, although many will also apply to other disciplines. Consideration will be given to the characteristics of engagement, factors which influence it and the differing levels at which it may occur. It will be seen that engagement is not binary: there are degrees of engagement and it can be partial, confined to elements of the course. This leads to three tentative models of engagement being proposed. The responses to a student being identified as disengaged are considered with potential unintended consequences. Initially however, issues related to the engaged computing student are discussed, looking at some of the factors which are particularly notable in their creation of student excitement, interest and appreciation.

Sources of data: theme ENGAGEMENT			
	Sub-theme		
	The engaged student	Disengagement - causes and manifestations	Responses to (presumed) disengagement
Study sources			
Preliminary	challenging, interest in computing, motivation	attendance, confidence, engagement	attendance - poor
Longitudinal	challenging, creative, exciting, fun, innovative, routine,	activity-led learning, anxiety, mathematics	
Focus group	all wired in, creative, exciting, flexibility, innovative, interest in computing, motivation, motivation - enjoyment, perfectionist, pleasure, sense of achievement	activity-led learning, anxiety, attendance, attendance - poor, attitude to university, confidence, determination, disengagement, emotional feedback, first year, first year never counts, learning, mathematics, motivation, motivation - challenge, programming, programming aptitude, progression, things are going to get serious, time management	attendance, attendance - poor, disengagement, expectation
In-module	all wired in, challenging, creative, exciting, flexibility, fun, imaginative, innovative, motivation	activity-led learning, attendance, mathematics, motivation, programming, time management	attendance
Engagement	creative, interest in computing, motivation - enjoyment	activity-led learning, anxiety, attendance, engagement, learning, mathematics, motivation - challenge, programming	attendance, expectation
Image participants	exciting	programming	

Data sources			
1:1 interview	all wired in, challenging, creative, exciting, flexibility, imaginative, interest in computing, motivation, motivation - enjoyment, perfectionist, pleasure, routine, sense of achievement	activity-led learning, anxiety, attendance, attendance - poor, confidence, determination, emotional feedback, engagement, first year, first year never counts, learning, mathematics, motivation, motivation - challenge, programming, progression, things are going to get serious, time management	attendance, attendance - poor, expectation
Group meeting	all wired in, creative, exciting, innovative, interest in computing, motivation, motivation - enjoyment, pleasure, sense of achievement	activity-led learning, anxiety, attendance - poor, attitude to university, disengagement, mathematics, motivation, motivation - challenge, programming, programming aptitude	attendance - poor, disengagement, expectation
Image competition	exciting	programming	
Image tagcloud	challenging, creative, exciting, fun, innovative		
Wordle™	creative, imaginative, innovative		
Image collection (<i>used in focus groups</i>)			
'Images of computing' scrapbook			
How did you decide: Pyramid of career influences			

Table 7-1: Sources of data: theme ENGAGEMENT³⁹

³⁹ Not all Data Sources applied to this theme

The derivation of theme and sub-themes: ENGAGEMENT				
Sub-theme	Category	Codes from text sources and ideas from lenses and other sources	Example quotations and examples of sources	Category informed by analytical lenses
1. The engaged student	intense, repetitive, innovative or fun	all wired in, challenging, creative, exciting, fun, imaginative, innovative, interest in computing, motivation, motivation - enjoyment, pleasure, routine, sense of achievement	"this is really for me"; "you've cracked it"; "I did have that pleasure of getting things to work"; "things like that amaze you"; "I'm really enjoying the course"; "you don't want to do anything else: your mind's already wired"; "I loved the idea of making software"; image (Les see Figure 7-2); Wordle (Michael and Victoria see Figures 5-4, 5-5), image tagclouds (see Alex, Dave, Emma, Jay, Michael, Rustyrose, Sunny and Victoria Table 5-1)	ANT
		group activities can energise students, engender passion and fully engaged them	Professional Practice	
	flexibility	creative, flexibility, innovative, perfectionist	"go off and explore"; "the freedom to do the work the way you want is very exciting"; "it's still not good-enough"; "having a sense of freedom and being able to look at this area and that area"; "before, you had to abide by the rules"	ANT S&A
		freedom within assessments enhanced students, sense of agency, students are provided with some scaffolding giving them structure and support	Structure and Agency lens	

2. Disengagement - causes and manifestations	subject does not fit needs - mathematics	confidence, learning, mathematics, motivation	"we use a lot of maths"; "the maths is very simple"; "it started off okay"; "he said the maths was important"; "I'm pretty good with the stuff so far"; "I went to the support sessions and they really help you", "the maths was a bit too easy"; "what's 'Logic and Sets'? well, it maths"	ANT S&A
		course structure forces students to take courses which do not fit needs (or interests) and student agency is evidenced in their responses	Structure and Agency lens	
		international students often report that the mathematics curriculum is simple	Professional Practice	
	subject does not fit needs - programming	confidence, programming, programming aptitude	"it would be a very silly degree for him to choose if he had no interest in programming"; "it's kind of daunting"; "we've only covered one programming language"; "I've programmed all through the night"; "I put more effort into [it] because I liked Python"; "I think I've got the programmer's bug"; "it's getting more hard"; "programming, I'm doing okay"; "they give you the freedom of programming choices"; "but the programming I don't like it thus far"	ANT S&A
		course structure forces students to take courses which do not fit needs (or interests) and student agency is evidenced in their responses	Structure and Agency lens	
		computing applications are now easy-to-use so the complexity of their creation is not evident	Preliminary Study	
		"easy things made hard"	Professional Practice	

	absenteeism	anxiety, attendance, attendance - poor, attitude to university, emotional feedback, engagement, time management	"I've tried ... [to] not skip classes"; "I hardly miss lectures. I value them that much"; "organise yourself"; "go off and explore"; "I was anxious that I'd be left behind"; "my attendance wasn't as good as it should have been either"	ANT S&A TSP
		changing the norm for an individual from attendance to absence; amassing human capital in the form of learning how the world works; developing habitus in terms of values and behaviours; norms of a lecture means most students do not expect personal support; some students seem unaware of expectations and conventions; human capital (as knowledge) will influence how well students are able to cope and whether they see any point in attending or engaging	Theory of Social Practice	
		norms and expectations (of teachers) may vary between classes; variable compliance with norms, such as attendance	Structure and Agency lens	
		integration is important since it seems to lead to better engagement	Preliminary Study	
	peer groups and habitus	attendance, attitude to university	"he was influenced by his friends";	ANT S&A TSP
		peer group structure influences individual's agency (including attendance, effort), but not deterministically; absenteeism exerts a structuring force so it may become a habit	Structure and Agency lens	
		many students are still developing into adults and working out their	Theory of Social Practice lens	

		norms and values; peer group norms influence the individual; group habitus guides the group's behaviours; an individual's social capital will affect how much they can influence their peer group		
		peer pressure can affect an individual's attendance; absorbing passion for computing is a result of an intrinsic interest in the subject; peer 'gossip' can misinform	Professional Practice	
	assessment - activity-led learning	activity-led learning, learning, motivation - challenge	"everyone learnt sort of most of it"; "so by Tuesday, we basically had [the week's work done]"; "I think it's very challenging"; "I like the fact that we are encouraged to work on themes"; "here's the task go and do that"; "I like the sort of scavenger mentality"	
	assessment - first-year contribution	engagement, first year, first year never counts, motivation, progression, things are going to get serious	"others haven't even done the work"; "I'm not too bothered about this year because as long as I pass then it's alright"; "things are going to get serious"; "the point of the first year is to learn the fundamentals"	S&A
		the contingency within the structure of the course regulations can affect students' response and agency	Structure and Agency lens	

	the disengaged	attendance, attendance - poor, determination, disengagement, engagement	"I didn't even bother to go to the second [Usability class]"; "I attended [only] one maths class"; "I'm not attending the Computer Club, that's my day off"; "my attendance isn't as much as it still should be"	ANT S&A TSP
		aspects of the structure of a module or course may lead some students to engage with it in a manner which differs from that intended by its designers, in some cases it can result in absenteeism	Structure and Agency lens	
		the course exerts social norms and requirements - socially constructed expectations	Theory of Social Practice lens	
		some students are entirely disengaged from their course; some students can reject the value or validity of some modules; disengagement can occur at a number of levels from weak engagement to complete disengagement; some students don't want to learn to program	Professional Practice	

3. Responses to (presumed) disengagement	labelling	attendance - poor, disengagement	"I've been a bad lad and I haven't turned up"; "I haven't turned up to any tutorials in about 8 weeks but I've been doing [the work]"; "I've missed about a third of the classes but I mean I was doing it from home"; "I only attended one maths class because it was frustrating"	
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	infantalisation	attendance, attendance - poor, expectation	"If there's a register then I'll more often than not go"	S&A
		break the norm of attendance; attendance may be an unthinking habit as a response to a norm or a response to a structural pressure such as attendance registers; professional development may be enhanced if students have the agency of personal choice to make appropriate decisions	Structure and Agency lens	

Table 7-2: The derivation of theme and sub-themes: ENGAGEMENT

7.2 The Engaged Computing Student

Considering the issue of what may lead to a student being fully engaged in their course, from an ANT perspective an AAD (§4.5.1) provided a means of focussing on relevant issues and relationships. Figure 7-1 shows some of the factors which promote engagement and those which might diminish it. Some issues may have either a positive or negative effect depending on particularities, such as the predisposition of the student. This figure draws from the empirical data but also ideas from the theory of engagement, as described earlier (§3.5).

To explore the nature and character of 'the engaged computing student', this section will start by considering situations where there is clear evidence of student engagement. This will be followed by a discussion of flexibility in assessment, a course design feature which many students particularly welcomed.

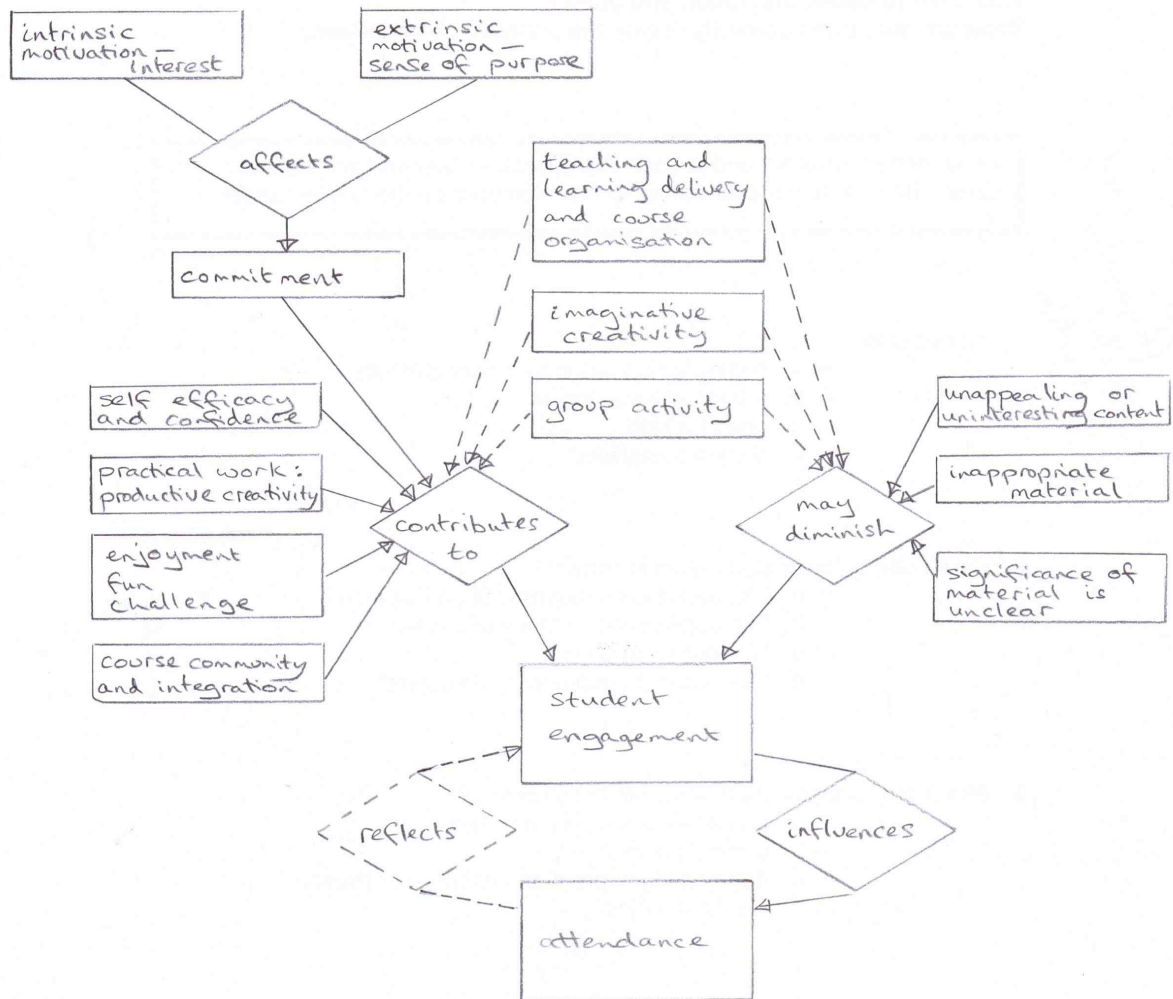


Figure 7-1: The engaged computing student

7.2.1 "Too intense and repetitive" or innovative and fun?

Whilst the majority of participants are clearly well-engaged with at least elements of their courses, most did recognise that some aspects of IT activity could be unappealing. For example, in discussing games testing:

"I think it's a bit too intense and repetitive" (Victoria-1#550).

Participants expressed their engagement in many ways, sometimes through their enthusiasm and excitement. For Michael, a student studying Creative Computing, the key part of his experience is its creativity. His Wordle graphic

(Figure 5-4), with the heavily-dominant terms of 'creative', 'imaginative' and 'innovative', makes this evident. Michael re-iterated their importance:

Interviewer: *"Creative, creative... that's a big part [of the course] for you, isn't it?"*

Michael: *"Yeah: to be honest, if it wasn't I wouldn't do it."*

Interviewer: *"So if computing was..."*

Michael: *"Dull."*

Interviewer: *"...routine and repetitive, even if it was actually producing new code as it were or new systems..."*

Michael: *"I mean to a point it is [...] routine but if I wasn't seeing something creative and imaginative, if I wasn't getting to use that part of my brain as well, I wouldn't do it. I'd drop out immediately" (Michael-7#8).*

It is interesting that he feels this quite so strongly. Michael initially embarked on a joint degree, which he failed. As described earlier (§5.2.5), he then sought entry to Computing but was offered a place on Creative Computing instead which was, in some respects, his third choice. Whether the offer was well-judged or merely fortuitous, Michael is enthusiastically embracing this course. (The significance of creativity is explored further, later, §7.2.2).

Michael may also be responding to, what he sees as the 'fortune' of, being given another chance at HE. His motivation to succeed is, in part, to prove his parents wrong and show them that he can do it (§6.2.1), although he also wants a degree to facilitate his international mobility. However he also talks with passion about the pleasures he gets from this course and thus he is both intrinsically and extrinsically motivated (§3.6). Considering the factors which influence engagement (explored earlier §3.5 and represented in Figure 7-1), Michael has a reasonably clear sense of purpose; he seems to be happy with his teaching and learning experiences and is confident in his abilities to succeed. This illustrates the benefit for students of enrolling on a course which they find engaging and intrinsically interesting.

Referring to the Usability modules, Omar explained how he found the practical elements to be most energising:

"The first term, the lectures weren't as engaging... There was useful information in the course, but they aren't as engaging... Once I got into the practical it was fun, but the theory and the lectures were quite dull. The second term has been more practical based" (Omar-2#122).

Whilst he recognised that the theory needed to be covered it was the practical application of those ideas which he enjoyed and found more engaging. Many computing students probably want to get on with the 'fun' and actually apply ideas. The balance between practical and theory has already been discussed (§5.2.2).

Les is also energised by his course. He is a Computer Science student at a 'red-brick' university and submitted the image in Figure 7-2 to the HEA STEM competition. In his submission he says that the image shows a 'student exhibition': a showcase for groupwork projects. Les might be the young man



Figure 7-2: HEA STEM image competition entry, submitted by Les

demonstrating the system that his group have created. The image shows a student, enthusiastically discussing their project with a visitor to the event. The competition asked for an image which "*captures the essence/excitement of your subject and might motivate others to study it*". For Les this project and the

exhibition were, presumably, positives and things he felt might attract others to study computing. Tellingly, Les had named the image file as *'Best Moments'*. Les was clearly energised and engaged, at least with this activity.

In practice many group projects can be like this, with the activity engendering a sense of dynamic passion in students. Sometimes students who may be daunted by, or struggle with, an individual project can gain confidence and energy and become fully engaged when working within a supportive group. Of course, groupwork can also often bring problems, difficulties and tensions, some of which will be touched on shortly (§7.3.4). The differing effects of groupwork on student engagement are represented in Figure 7-1.

These are examples where the students were enjoying the task set; where they were involved in their work and where they were engaged. They were having 'fun'. However it is unlikely for any student to see their whole course as being exciting and fun. In computing, as with most if not all other subjects, there are aspects which a student may find routine, more abstract, uninteresting or simply harder. Nonetheless engagement with these aspects of their course is desirable too. Figure 7-1 indicates that enjoyment, and the like, have a positive impact on engagement whilst unappealing or uninteresting content may diminish it.

7.2.2 "Go off and explore": flexibility

As Chapter 5 showed, a course feature many participants appreciated was the flexibility and creativity permitted by some assessments which were loosely specified. Whilst many participants appreciated this, there was a range of reactions. In at least one assignment they were told: *"given this scenario, develop a solution"*. It was not even required that the solution involved the significant application of computers. Omar, a Games Technology student, found the agency conferred through the freedom in assessment, to be a pleasant surprise.

"So he'll give you information, he'll make the information relevant, but he won't give you all the tools, or won't give you the perfect format that will work. He'll just put a path in front of you, like a crossroads and that's basically where you get to choose and where you want to go. [...] It takes a lot of getting used to" (Omar-2#178).

Omar acknowledged that the flexibility which he was enjoying was not universal across all courses. He accepted that he was expected to go and find the information he needed but recognised that he had been provided with scaffolding.

John also commented:

"The reason why I enjoy the freedom of it is because... we're on a creative computing course. And before [...] you had to abide by the rules sort of thing. [...] Just for once to have that idea of you can solve it any way you want: you can be as creative as possible. And there are like millions and millions of solutions to it, just the whole idea of you know... your freedom of how to do the work the way you want was, you know... it's very exciting" (John-1#196).

As already discussed (§5.2.5), the term 'creative' has dual meanings. Depending on the precise course, students learn to 'create' multi-media artefacts (such as graphics, animations, computer games) and to be 'creative': to design the innovative and novel. So for John, another Games Technology student, creation is part of what he would expect although he might not expect to be allowed to be imaginative.

Whilst the creative computing students are not the prime concern in this study, several other participants also spoke positively of the freedom and flexibility in the requirements for their work. Victoria and Avtar, both Computer Science students, commented appreciatively (§5.2.5) and Carl, another Computer Science student, said:

"I think that's what I find most enjoyable about it, is you get that opportunity to explore things, you know, interests or something that you're not sure about, or you want to work more on and do that" (Carl-2#106).

Whilst flexibility is appreciated by many students, it is not entirely positive since it can lead to uncertainty. Omar commented:

"You're given a vague amount of information and then you're told to go off and explore and do as much as you want really" (Omar-2#16).

And later:

"When you look at the work [...] and say: 'well how much do I put into it? how much do I keep going?' It's quite hard, but do I keep going, do I keep

trying? [...] It's even worse if you're a perfectionist. [...] You look at this piece of work you've done and you'll say: "it's still not good enough" and someone will say: "oh that's OK, it's pretty good" and I've said: "no, there are still lots of things I can improve and there is still more I can do, tidying it up" " (Omar-2#32).

Omar has very mixed feelings about this flexibility. He clearly enjoys the agency it gives but is disconcerted by its open-endedness. He hopes to recognise the 'end point' of an assessment, to recognise the point at which he can say: "*it is finished*". Figure 7-1 indicates that whilst practical, productive, creative work enhances the engagement of computing students, assessment which requires imaginative creativity can diminish it, for some students.

Another aspect to this tension lies in the degree of pre-assessment scrutiny and advice from staff. In HE deciding when work is 'good enough', against a combination of learning outcomes, assessment criteria and a marking scheme, is usually considered to be part of the assessment process. The open-endedness of some assessment briefs brings into sharp focus this requirement for self-evaluation.

Flexibility in assessment seems to be welcomed by very many students but it is somewhat mis-aligned with much of the IT industry. Overall, the IT profession's fundamental task is to deliver systems and software solutions to fit clients' needs. There are job roles in some IT sectors, where creativity and imagination are very important but in many roles the client's requirements dictate the work required. Students may not be aware that this is the way they may be required to work and for those who like rules and rigidity in their lives, such a regime is likely to be welcome. However for students who enjoy being able to experiment and derive ideas and solutions of their own this may be most unwelcome indeed. There is a move towards a pattern of working more closely with the client throughout a project, and iteratively developing a system together (Computer Weekly 2013) and this is likely to be experienced somewhat less prescriptively.

Many students welcome flexibility and are empowered by the limited structuring of these assessments. Hence providing flexibility can be seen to be supporting engagement, by providing a positive learning experience, as indicated in

Bryson's (2010) engagement model (§3.5.1). By offering flexibility there is also the potential for a student to tailor their work towards their personal interests. In Lent and Brown's engagement model (Alexander *et al.* 2011) (§3.5.1) this interest is seen as supporting student involvement. To be required to design solutions and consider all the associated issues would seem to be a beneficial developmental experience for all students, even if the flexibility is sometimes uncomfortable. However, for reasons of fairness and student reassurance, it is important that students are given enough guidance so they can reasonably be expected to be able to judge when their work is complete. To permit fair marking all assessments must be bounded, to some extent.

Another tension with flexible assessment is the contrast with those which are tightly defined which may, by contrast, be felt to be limiting and students may feel that their agency is impeded. For example, John said "*you had to do... you had to work within the rules*" (John-2#198). Students need to understand the rationale for the design of their assessments and, most particularly, they need a mix of assessment types which will adequately support their development for moving into their likely job roles. However work with flexibility, which supports innovation, appears to be helpful in engaging many computing students. The opportunities to exploit this in course design are explored in Chapter 8 and the implications for stakeholders in Chapter 9. Many students engage well with their courses, taking advantage of the opportunities and facilities available. However this is not always the case and some students fail to make use of all their learning opportunities.

7.3 Disengagement – Causes and Manifestations

There are numerous reasons why a student may not take part in all the learning opportunities offered, including curriculum issues, peer pressure and issues related to assessment regimes. For instance, as Chapter 6 showed, students are sometimes surprised by aspects of their course curriculum. However, as will be seen, students who do so should not necessarily be regarded as disengaged.

7.3.1 Subject does not fit needs

One reason why a student may decide not to attend classes is if the subject does not fit students' perception of, or their actual, needs. This is most likely to occur in subject areas where students have very diverse backgrounds. In computing courses this applies most particularly to their mathematics and programming components. This is represented in Figure 7-1 as 'inappropriate material', which may diminish student engagement.

Mathematics

Mathematics is one of the subjects which underpins computing technologies (Chapter 2), however entrants to computing courses at Coventry vary very widely in their mathematics background. A number have good grades at Mathematics A-level but most have not studied any mathematics since GCSE which, for some, was many years previously. A minority of students need to start at a very basic level including, say, manipulating fractions. The Coventry course requirements specify that all students need to study these modules and understandably students react in diverse ways. As discussed further later (§7.3.5), Dee came to the UK from an Eastern European country where the level of school mathematics exceeds that experienced by most pupils in the UK. In professional practice, international students frequently make such comments.

"The maths over here is very, very, very, very, very simple. It's very simple, yes. I've looked on the module, so there would be some more complicated stuff, like matrices and some differential equations, but they're still pretty easy" (Dee-1#148).

Dee was clearly not anticipating learning very much in his mathematics module but in other respects he was emotionally involved in his course. Nick, also from Eastern Europe, reported the mathematics content to be new to him, but easy. Nhoj Xela, yet another student from Eastern Europe described it as a 'joke', it was so easy. By contrast, towards the end of the year, Ez was struggling but with support appeared to be coping:

"It started off okay, but then it just went hard like. [...] So I started going to maths support sessions in the library and they really help you as well. They guide you in that direction so, so far, I'm okay with maths" (Ez-1#212).

Ez is finding the mathematics to be problematic but he has a positive attitude to his situation and is making efforts to understand the material.

Nonetheless, accommodating the range of mathematical competence of recruits makes course design problematic and computing students do need some level of mathematical proficiency. However not all students expected any mathematical content. Jessica, who had struggled with her GCSE Mathematics, was pragmatic in her surprise " 'Logic and Sets' *is maths really but is applied into programming*" (Jessica-2#201). However some students, particularly if they are mathematics-phobic, may reject the legitimacy of the material. This has been encountered previously, in practice.

The rules of course design at Coventry University prevent material being included which is compulsory for some students and yet can be ignored by others. The strategy adopted at Coventry has been three-pronged: to ensure that all students recruited have GCSE Mathematics at grade 'C' or higher (or an alternative); to start the teaching from the lowest level, to help weaker students cope and to provide a drop-in Mathematics Support Centre. This structure means that mathematically-strong students (such as James and Michael) may choose to engage with this module, only to the extent necessary to secure the credits, and weaker students (such as Ez and John) may need to use the support facility. There is the risk that such arrangements could lead to weaker students feeling stigmatised.

The Yorke and Longden (2004) engagement model (§3.5.1) shows that a lack of understanding of the significance of material can lead to poor engagement. The Lent and Brown model (Alexander *et al.* 2011) (§3.5.1) highlights the importance of self-efficacy and expectation of success. However it is hard to design a programme which provides these for the mathematically very weak, who may also lack mathematical self-confidence. These structural course design issues are not easy to resolve. However, unhelpful arrangements run the risk of demotivating students, leading to them disengaging from their mathematics and perhaps other modules too.

Programming

Programming is another aspect of courses where diverse interests and aptitudes present challenges for course designers, and many students. A minority of students are expecting a course which focuses on programming (such as Farouk and Teken) and a few (such as Omar) seem not to be anticipating any material akin to programming (§6.5.2). At Coventry, in an effort to target the programming content to the needs of the students' courses, separate modules are offered for students on computing and those on 'creative' routes. Nonetheless, in line with many institutions (§2.8), significant numbers of students fail their programming modules. Students enter with a wide range of programming expertise, many having never done any. Additionally, as already described (§6.5.2), some students' programming background provides a more useful preparation than others. No experience is expected and hence teaching starts with the basics. For students with significant background and an appetite to move on, such as Michael, this can be frustrating. At Coventry tasks are sometimes set which provide an extra challenge, a 'sting', but this can be difficult to accommodate fairly in the assessment regime.

By the time of his March interview John was finding his Python programming difficult:

"Well Python's easy but sort of some of the logic in there I didn't get so this afternoon I'm going to have to ask my teacher to teach me again" (John-2#146).

John seems to have a mixed relationship with Python. He says it is easy but then says he will need to seek extra help to understand the material. This is redolent of a student encountered in practice, who once characterised programming as: *"easy things made hard"* (personal observation). Such comments seem to relate to the pernicketiness of programming: that care and attention are needed to create a solution, but when reviewing a solution it can appear trivial and obvious. John elaborated later:

"Yeah the language [Python] is near-enough simple. It's sort of reminds me of like a mixture of VB – VisualBasic – but it doesn't have any interfaces for me to work with. You have to like design all that yourself"

which is new to me 'cause I've never done that. I'm all... I was always used to like you know getting like spoon-feeding" (John-2#158).

John seems to have expected that his previous experience of programming in VisualBasic would have been more useful to him in his Python lessons. As he explained, VisualBasic does some of the work for the programmer, leaving some issues invisible. Whilst he understands this, he seems frustrated by it.

Omar also has a mixed relationship with Python:

"But the programming, even though I don't like it thus far... I do enjoy it but it's also daunting at the same time. I know I'll enjoy it later on, but for now it's not, but that [programming] is the main reason why I want to do Games Technology anyway" (Omar-2#204).

And then later:

"I think it's very much like maths, programming. Whereas when you first look at programming and if you don't immediately get a connection to it, you shut off. It's kind of daunting, like: "no, it's too complicated I can't do that". [...] It's complicated as well, but it is simple – it's just building blocks really" (Omar-2#262).

Students such as Omar and John find their programming to be a challenge but both have a reasonably positive attitude to it.

Programming is central to computing and students really must get to grips with it (§2.4.3, §6.5.2). For course designers the issues are similar to those with mathematics: students enter with a wide-range of backgrounds, indeed many are absolute novices, and yet all students need to develop at least a core level of competence. At Coventry University this is addressed by trying to support the weaker or novice students to gradually develop their understanding and skills. Numerous opportunities are made available for them to ask for help and practical sessions are quite well-staffed so as to help anyone who is struggling.

However the issue of the struggler becoming embarrassed by their difficulties could be acute in programming. The ridicule articulated by Michael *"that's pretty much what it says!"* (Michael-1#619) (discussed earlier, §5.2.4) typifies the sort of attitudes which they might encounter. Also, sometimes, a student may find themselves embroiled in competitive, intimidating power-struggles of egos with

their experienced peers. Whilst their objective is not usually to intimidate the strugglers, there is a danger that this is a side-effect. A student who is struggling may be willing to face all this or they may absent themselves from practical classes. They may decide to tackle their tasks in private but, without access to help they may well find it difficult to progress. It must take a determined student to remain engaged with a module under such circumstances. The implications for course designers of recruitment of students with diverse needs are discussed in Chapters 8 and 9.

7.3.2 *"If you skip, you lose": absenteeism*

Whether it is the result of inappropriate mathematics or struggling with programming or for some other reason, absenteeism is a significant concern since it can put students' progress at risk (NAO 2007). Sayers, Nicell and Hinds (2010) reported a correlation between the attendance and performance of their computing students. Attendance was discussed with many of the engagement participants, who mostly appreciated the importance of attendance:

"I have tried attempting everything and not skipping classes because if you skip, you lose and if you lose, you stop understanding properly the courses" (Dee-1#64).

By contrast, James had started the year by missing just a few classes but over the first few weeks he developed a habit of absenteeism and missed most classes. He had expected to be able to learn from the copious resources available on the Virtual Learning Environment (VLE). However he found that getting to grips with material using just these resources was problematic, particularly topics which were entirely novel to him, and he struggled with the assessments. However he graphically described his habit of absenteeism as being like a tornado:

something which is hard to escape (Figure 7-3). The tornado can operate to change the norm for an individual, from attendance to absence.

"It is like a tornado and you get caught in it and skipping classes and once you skip that you skip something else - so you need to learn so... But if



Figure 7-3: The tornado of absenteeism

you go to all of them [classes] then it makes it harder for you to skip one but when you skip one it makes... You get used [to it] so you make it a routine to not go so... It is hard to get out of it" (James-1#215).

By the time of his interview in January, James claimed that his attendance was much better: *"I'm trying to fix that now and I have been to all of them" (James-1#203).* He certainly did seem to understand the issues involved. James' absenteeism seems to have started with his Usability module. The material is not very technical and James, a student from Eastern Europe where computing courses seem to be dominated by the technical, did not immediately appreciate its significance: indeed he was very quick to judge the module negatively.

"Well the thing is Design for Usability, I think only the first class was not that interesting but I didn't even bother to go to the second one" (James-1#209).

Looking at the models of engagement (§3.5.1), for James the lack of a sense of purpose had diminished his commitment to the module. Latterly, James had realised that missing these classes was building up problems and he was finding it hard to cope with that module. However he still felt he could cope adequately without attending other modules where his background was quite strong: the mathematics and programming. For James the course comprises completion of work, only, and he was keen to do that. He did not feel that undertaking a course is also about engagement with his subject more broadly or engagement with his peers academically. James was not looking for any form of community (§3.8). This will be discussed in the next chapter.

Early Monday morning or late Friday afternoon timetables can be problematic for some students who maybe undertake weekly commutes or weekend travel. However there are many reasons why students may miss a class. Most students are 18-years-old when they start their course and are still developing into adults. They are expanding their human capital (§3.3) and learning how the world operates. Their human capital will affect how they cope with their course but also whether they see any point in attending classes or fully engaging with their course. Students are still developing their values, dispositions and mindsets: they are developing their own habitus (§3.3.2). The effect of peers on the development of habitus will be discussed shortly (§7.3.3). The habitus which a

student develops, their perspectives and values, will affect whether they feel there is any benefit from attending classes but also whether they see it as their duty. For instance, sometimes students see a lecture as simply the means to acquire a set of notes and they may believe that downloading them is a full substitute for attendance. These points will be developed later, when considering the academic community (Chapter 8).

John is another student who was both routinely absent and yet 'in contact with' his course. John lives some distance from the University and needs to catch two trains to attend. He routinely arrives almost an hour late, for his twice-weekly 9 o'clock classes.

"I feel disappointed in a way that I keep missing out on stuff but [...] at least I'm devoted-enough to turn up and catch up on everything" (John-2#32).

John says that he would prefer this were not the case. Nonetheless, he sees no problem in asking a lecturer, routinely, to repeat the missed material with him individually.

John: "But I don't miss much because at the end I go to the teacher and sort of ask him to sort of revise again... It's all like..."

Interviewer: "Is he willing to do that?"

John: "It's all like quickly go over it sort of thing."

Interviewer: " "I walked in late, so you do your job again", yeah?"

John: "Many people walk in like even later than I do: they walk in like an hour and 15 minutes [late], after me."

Interviewer: "I know but to do it regularly is..."

John: "It isn't right but... yeah" (John-2#44).

It seemed to be only during this discussion that John realised that this behaviour may not be entirely appropriate. Indeed he sees himself as being a conscientious student who takes steps to catch up on the classes he misses and sees himself as fully involved with his course. John does not seem to think that the lecturer has the right to assume that students will try to arrive on time. Also, he does not see that the lecturer is being particularly supportive by assisting him

in this way. John simply seems to feel 'entitled' to this help: entitled because he sees himself as being conscientious by endeavouring to catch up. The norms of a lecture produce a structural constraint which would lead most students to feel disempowered to ask for personal support in this way, but not John. The significance of absenteeism for course design and management are discussed further, in Chapter 8.

Thus there are many reasons why students may routinely miss classes and, as will be explored further later (§7.3.5), just because a student is absent does not mean they are necessarily disengaged.

7.3.3 Peer groups and habitus

It is recognised that peer group structures affect attendance patterns (for example, Price, Handley and Millar 2011). The norms of the peer group can lead to individual students adopting a particular pattern of attendance, either to them attending or to their absence. It is evident from practice that sometimes explicit pressure may be exerted: *"Oh why would you want to go to that class?"*, but more routinely it is likely to happen simply through the desire to conform.

Understandably most students, especially in the early weeks of university, are keen to build friendships and to fit in (HEA 2012b). However sometimes it seems, such is their lack of security socially and the structure of their immediate peer group, that they may be keener to adopt the norms of their peers than follow advice from staff. An example of a Coventry computing student, who did just this, was reported on Facebook and is described shortly. This is not to suggest that peer group power is absolute, but an insecure student, particularly if they are keen to fit in, is unlikely to consider behaving differently to their group but like a Pooh-stick simply 'go with the flow'. Of course the reverse also applies and sometimes students attend simply because their peers do. Sometimes however a student may ignore their peers. For instance a student may be nervous about their academic abilities but very keen to succeed and therefore attending class may be more important to them than the views of their peers. Certainly Jay was very clear that he wanted to make the fullest use of all the (academic) opportunities available, in order to maximise his achievement.

For many students the development of a close group of friends is really very important (NUS 2012). Often these will be dominated by students from the same or a related course. As they get to know each other, they will negotiate 'ways of being' with each other. They will, probably subconsciously, work out the groups' norms and values, and individuals' power statuses. As each student grows and develops their personal habitus (see §7.3.2) so the group develops its own 'group habitus'. These are closely interdependent, and affect each other as they develop, but they are separate (Figure 7-4).

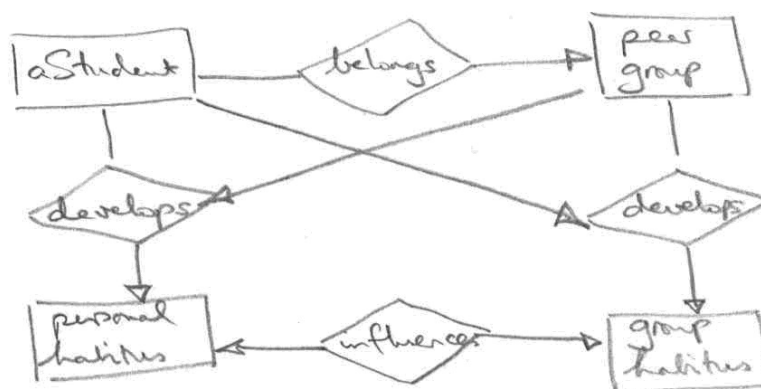


Figure 7-4: The development of habitus

The group habitus will guide the peer group's behaviours. Members of the group are likely to have similar interpretations of situations and adopt similar behaviours, based on that group's habitus (Clark and Zukas 2012). However this is not to suggest that an individual has not got their own agency. They can take a route separate from their peer groups, but whether they do or not will depend on their personal habitus – how they themselves view the situation - and the strength and nature of the structures in the group. In a Facebook discussion about absenteeism, a student on one of these courses recently commented that foolishly he had been mimicking his peers' behaviour by going to classes for just long enough to be marked as present, and then leaving. He recognized that his attitude to attendance was inappropriate but also that he was being influenced by his peer group. If an individual has strong enough social capital, and self-confidence, then they may be more able and willing to resist or to redirect their

group's behaviour, when it contradicts their personal inclinations. Nonetheless peer group habitus can be very influential to an individual's behaviour (Figure 7-5).

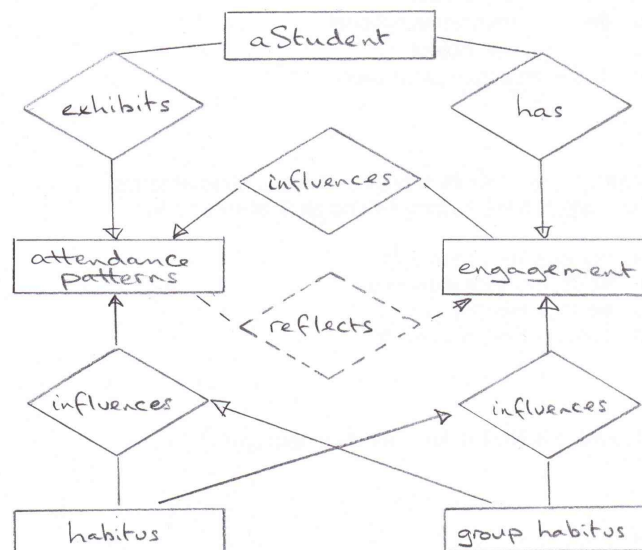


Figure 7-5: The influence of habitus on engagement

The peer group's habitus can influence whether a student is present in class, whether they fully focus on the teaching session and when they complete work set. It can influence how they react to teaching, material and directives. The relationships shown between attendance and engagement will be discussed later, under disengagement (§7.3.5). Hu and Kuh (2002) suggested that being around peers whose prime motivation is to get a good job can discourage engagement. Many computing students appear to be primarily extrinsically motivated (§3.6) but this research provides no evidence to indicate if this leads, as suggested by Hu and Kuh, to reduced engagement in their peers. From practice it seems that an intrinsic interest is what leads to the all-absorbing passion for the subject exhibited by some students. However there is some weak evidence that even computing students with high extrinsic AMS motivation scores also often have strong intrinsic motivation (§3.6.1). In Chapter 5 it was noted that some participants were clearly motivated by a strong intrinsic interest

but others had more of an extrinsic motivation, based on employment or salary expectations.

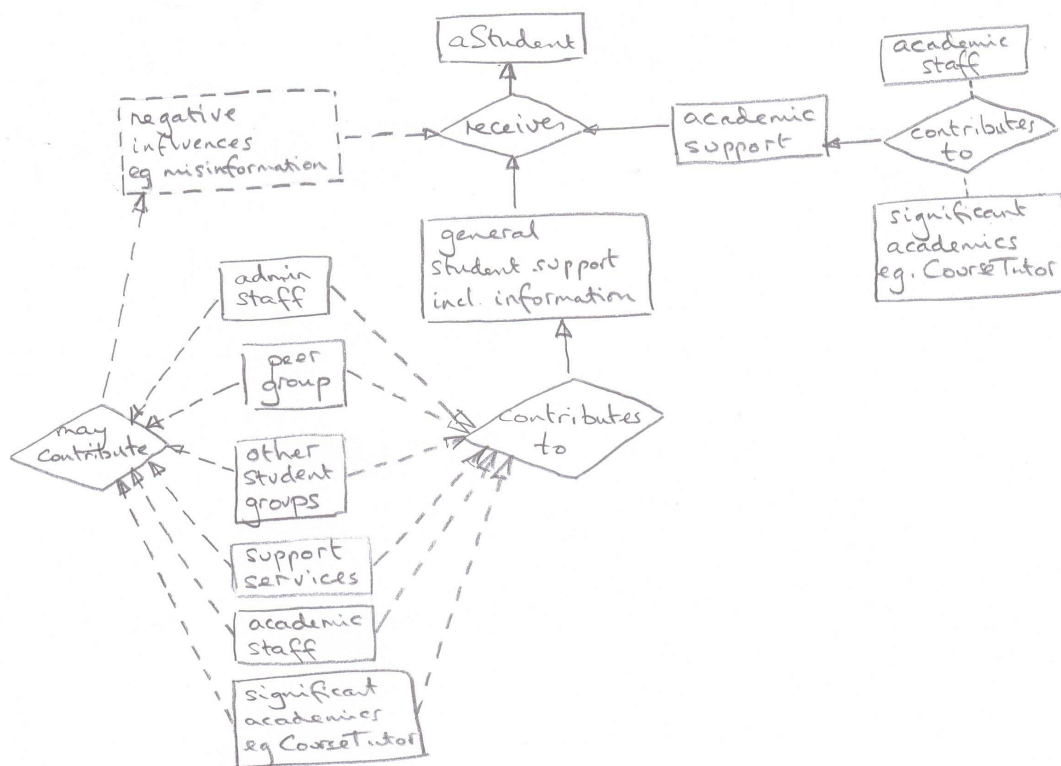


Figure 7-6: Sources of student support

Sometimes the social interaction amongst a peer group leads to a better understanding of the course regulations and their potential implications. However from practice it is clear that peer 'gossip' often misinforms. *"They can't fail us all"* is a view which has needed to be quashed on more than one occasion. Figure 7-6 shows the sources of student support. Through this lens it is very obvious that the sources of support available to a particular student are unknown. Support relationships are all uncertain and should be seen as 'fire', and optional. In reality it is likely that almost all students do have a peer group from which they draw support and almost all will get some support from some academic staff. Figure 7-6 also highlights the negative influences which students can receive from some of their sources of support. Thus the relationship

between a student and their immediate peer group can be an important factor, not just in whether they are present in class or not, but also in their knowledge about their course (Price, Handley and Millar 2011). The importance of the student community will be explored further in the next chapter and the implications for stakeholders are in Chapter 9.

7.3.4 Assessment

Thus far the focus has been on the manifestation of student disengagement as absenteeism. However attitudes to the work set, and particularly to assessment, can also illuminate students' relationships with their course and their engagement. This will be explored by considering the Activity-Led Learning project and then the course regulations relating to first-year students.

Activity-Led Learning

From 2009, the Faculty of Engineering and Computing at Coventry University adopted Activity-Led Learning (ALL) as its preferred pedagogy and, most particularly, for a group project which forms the core of an extended induction for first-year students (§2.4.6). The focus groups were held during this period (§4.5.3) and, unsurprisingly, these projects were raised. However, other participants mentioned it too, both 'applicant' and 'engagement' participants. Jessica, an applicant, applied to Coventry because, after attending the Open Day presentations, decided that she liked the way the course was taught and particularly the ALL. Farouk, a focus group participant, had not expected this project but he had not attended any of the Open Days where it would have been described and it was not featured in the relevant prospectus.

"The first six weeks, ALL, that was surprising actually [...] So that six weeks helped a lot actually" (Farouk-2#230).

It was not explored how it had helped him but clearly he found it useful. And, similarly, from Dee, a first-year 'engagement' participant:

"Yes, it was very different. I liked the fact that again, they encouraged teamwork and I like the sort of scavenger mentality that [the lecturer] talked about in the opening week. Basically, you're given a task and you're told: "Here's the task. Go and do that." And you have to study everything on your own and it sort of gives you this idea of

accomplishment, so you know that: "Oh I've built this [bit], so I helped built this [bigger thing]" " (Dee-1#74).

Both Farouk and Dee were quite positive about their experience. Dee, in particular, also expressed a pride in his group's accomplishments and believed significant learning extended across his entire group:

"I can't speak for everyone. But I think everyone sort of learnt most of it – not all, but most of it" (Dee-1#107).

Whilst all students in Dee's group may have taken a significant part in their project, and learnt new things as a consequence, this is not always the case and sometimes engagement is patchy. In Michael's ALL group the lack of assessment led to reduced engagement:

"There were people in my group who were like: 'What? It's not graded!' People don't [all] have the motivation to do it" (Michael-7#110).

Michael was irritated and inconvenienced by his group members' attitudes. He was able to see the benefit of the task but recognised that a number of other students were motivated by their marks. Arthur, an 'engagement' participant, felt the project was unnecessary:

"There's one thing that I thought was completely unnecessary [...] it's the six-week challenge. That was a waste of time. [...] It's [done] to gauge the level of the student or to get you more interested, but I found that I could have been using that time to do something more productive. [...] I reckon it could be done in a shorter scale of time. [...] Some people I know are in their first year as well, they've already gone straight into their course. They're like in labs and they're actually doing what they're meant to be doing" (Arthur-1#185).

Arthur raised this many months after the project had been completed. It still irritated him. Whilst he was aware of some of the rationale behind this teaching structure he clearly saw little benefit and indeed he did not see it as being part of his course.

The project for Arthur's course was to program a Lego® robot to respond to a range of stimuli. The equipment required them to work with program code which has many of the characteristics of a 'professional' programming language. This was novel for most students but Arthur had done something similar previously.

Whilst this is unfortunate many students would respond, in those early days of their course, by using the project as an opportunity to 'show off' and enhance their reputation with their peers. However Arthur just found it irritating.

Arthur, as a recent immigrant, is not typical. He is anxious to progress and make full use of his opportunities. From this context it is understandable if he is less tolerant of arrangements which he sees as not being very productive. Whilst Arthur's position may be somewhat unusual there are other students who also see this ALL project as being peripheral. For instance, the students who Michael referred to seemed to view the lack of assessment as meaning the activity was unimportant and absented themselves. Some other students saw the only benefit of the ALL as being technical learning, and not acknowledging the friendship-making or interpersonal and study skills development and other benefits. As already observed (§7.3.2), some students see their course as just its 'academic' content and, for a few, just their marks.

"Learn the fundamentals": first-year contribution

Another issue which affects the significance which students attach to their assessment relates to the fact that, in line with regular practice nationwide, the first year of Coventry University degrees are not included in the calculation of final degree classifications: the first year does not 'count'. However students must pass their first-year modules to progress and students generally are aware of this. Carl commented:

"Someone said, 'Well I'm not too bothered about this year because as long as I pass then it's alright' and I'm like, well the whole point of the first year is to learn the fundamentals so you can use those fundamentals in the next two years" (Carl-2#166).

Carl recognised the loss of learning opportunity, but also that students who adopt such an attitude may not succeed in their degree at all. He realised that whilst first-year marks do not 'count', the learning most certainly does. John was also aware of the regulations.

"The idea in university is... this whole idea of... sort of the first year sinking you in it's... I'm almost glad it's there sort of thing. Okay,

everybody, including me let's say, we take [the] first year for granted we really do" (John-2#450).

John recognised the rationale for these regulations but he also believed that students tended to relax and become a bit blasé about their presumed progression onto year two. John was uncomfortable whilst discussing this and seemed to be identifying with this risky reaction, acknowledging that he was not working to his full capacity, despite previously referring to himself as conscientious (§7.3.2).

The structure of these course regulations affects some students' behaviour. Whilst they have the agency to fully engage, they respond to the contingency provided through the structuring regulations and exploit it, probably to their long-term detriment. John Raftery, ViceChancellor of Oxford Brookes University, believes that by changing degree regulations, such that the first year does count, would address such engagement concerns and "*increase student motivation*" (Raftery 2013:32).

Many computing courses, including those at Coventry University, do not have particularly good progression rates (§2.4.3). Whilst these data are not private they are not usually made evident to new students. In professional practice on a few occasions attempts have been made by Course Tutors to communicate the situation to students, in the desire to encourage student effort. But some students' reaction was, "*if this is the position then why scare us by telling us*". Not only does this suggest that they believed that outcomes are normalised but, more importantly, they did not think that they had any agency to affect their personal outcomes.

If some students do not believe that they can improve their academic outcomes as this suggests, and if they are struggling with some content, then they lack the self-efficacy which Lent and Brown (Alexander *et al.* 2011) (§3.5.1) believe is a crucial precursor for engagement. Additionally, if some students believe that the only benefit of working in year one is to achieve the credits needed for progression, it is not surprising that they opt for the 'easy route' and do minimal

work. Students might benefit if they were clearer about how learning works and the expectations and their responsibilities in this regard.

7.3.5 The disengaged – who are they?

Are absentees disengaged?

James and John are both students who exhibited low levels of attendance (§7.3.2), which staff might take as an indication that they were poorly engaged. However neither of these students would see themselves as being disengaged from their course, indeed John was very clear that he saw himself as being conscientious since he tried to catch up with missed material. James would probably agree that initially he had been somewhat disengaged from the Usability module which he did not see as being particularly interesting. However, even for that module he did (at some point) grapple with the topics using the online materials. James and John both remained committed to their respective courses; and John, most particularly, remained broadly in contact with their studies. (Whether they are really as committed as they assert, and perhaps sincerely believe, is a moot point. They could be deluding themselves. However this is only of slight consequence here.) From a feminist stance and borrowing from disability theory (Wendell 2006), these students could better be considered to be 'differently engaged': they are engaged with their course but choose to exercise their agency in a 'non-conventional' manner. Whilst not suggesting that their engagement could not be more 'fulsome', the significant point is that they are still broadly in contact with their course but not behaving in the ways conventionally expected.

This pattern of retaining a commitment to mastering their course, despite significant absence, was the case for all students interviewed where absence was discussed. This includes most students recruited on the engagement research study and a few others. This was represented in Figure 7-1 and Figure 7-5 by the relationships between attendance and engagement. The level of a student's engagement affects their attendance patterns but the reverse may not be the case. This is a 'fire' relationship – one which may be present.

In saying that absenteeism is not always necessarily an indicator of disengagement it can still, of course, be problematic. It can be very easy to get sucked into a habit, a tornado, of absenteeism (§7.3.2). Whether it starts as casual absenteeism from a few classes or a considered, strategic absence, when a student misses classes they risk gradually losing connection with the dynamic of the module: they are likely to start to lose touch. They may be able to get all the materials online but, even if they use these methodically, there is a risk that the bonds diminish over time. It is then possible that the student starts to lose their emotional attachment to the module and that they start to dis-engage from trying to master the material. Thus, possibly slowly, possibly swiftly, absenteeism can lead to disengagement.

For many individuals there were specific reasons for patterns of absences, such as John's apparent lack of early trains and Arthur who had to deal with a complex personal situation which took several months to resolve. Sometimes patterned absences were quite strategic and considered. Most notably, many Eastern European students (such as James) absented themselves from their mathematics module (§7.3.1). Some of them felt, probably correctly, that they had previously covered this material, and perhaps much more. Some other Eastern European students (such as Dee and Nick) felt that, although they had not previously covered all the relevant mathematics, that these topics were very easy and that they would readily cope without attending class. The 9 o'clock lecture schedule may have encouraged absenteeism for some but these Eastern European students simply decided that it was not worth their time attending. Their absenteeism is a considered, agentic response and a direct consequence of the structure their course.

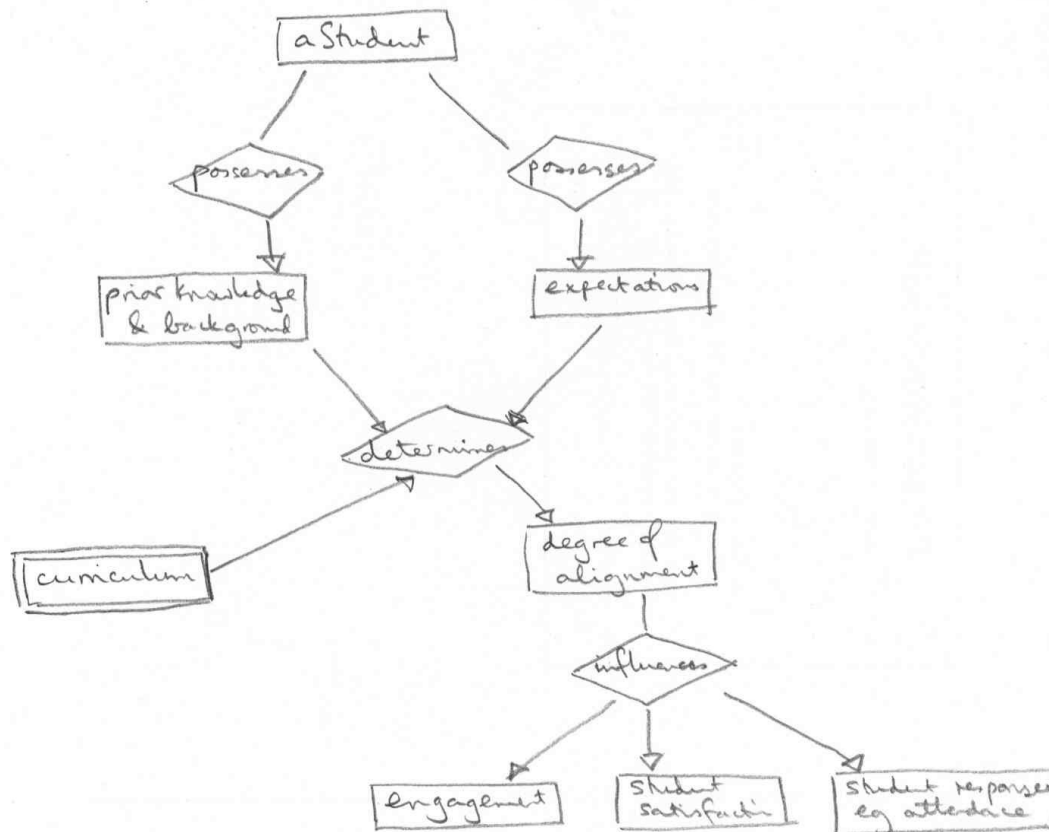


Figure 7-7: Alignment with the curriculum

Figure 7-7 shows these relationships, illustrating how the alignment of the curriculum with a student's personal background and their expectations can influence a number of things, including their attendance, engagement and satisfaction. The creating of this diagram highlighted how the curriculum is relatively static and is common to all students (on a course): an 'immutable mobile' actor. All other actors here differ between individual students and most can change over time and are therefore represented as 'fluid' actors. This highlights the uniqueness of each individual student and that a fixed curriculum structure is unlikely to ever suit the needs of a range of students and therefore the more diverse the students, the poorer this alignment is likely to be for some. As implied by Lent and Brown (Alexander *et al.* 2011) (§3.5.1), a curriculum which is significantly misaligned for a student is quite likely to lead to a weakening of their engagement, as well as impacting on their satisfaction.

There is a real imperative to use attendance or assessment submission data in an attempt to identify any disengaged students. Student engagement is seen as being important for success (NAO 2007) and, administratively, using such data is convenient. However these data must not be taken as anything more than an indicator of possible disengagement – as a proxy measure. But even then there can be significant consequences, some of which will be discussed later (§7.4).

Levels of disengagement

Disengagement where it does exist can take a range of forms – it can operate at different scales. Sometimes students opt out of the teaching process for a single module but remain in touch with the module: they are 'differently engaged'. The mathematically-adept students, who need to learn a new but seemingly straightforward topic, and decide not to attend class, can be considered to be doing this. Sometimes this can occur because the student does not 'get on' with the teaching style (or lecturer) and they decide they would be better off learning the material on their own. Commenting on his persistent absence from a second-year module, Pete, a final-year student, said:

Pete: "I could learn everything from the lecture slides. It was going to the lectures and I don't particular like the way that [lecturer] teaches. That's just me personally because I'd rather fall asleep in the lectures and I wasn't learning much there."

Interviewer: "Right, so you went to the meeting and [...] said, "I will do better now"?"

Pete: "Yes, I think I went to one or two afterwards, just so that they wouldn't ring me up again, but yes. Going to lectures have never really been my... yes, I kind of dwindled near the end of the years going to the lectures because I just don't feel like I'm learning anything more. [...] I learn better from the resources on Moodle than I do from the hour lectures" (Pete-1#488).

Students such as Pete can have completely opted out of the teaching delivery of a module and yet still be engaged with the learning, assessment and so forth. They are still trying to master the material and to pass the module. Certainly Pete's commitment to pass seemed undiminished: he was still emotionally connected. Pete will be discussed further below (§7.4).

In professional practice, sometimes it has been observed that students reject the value or validity of one or more modules, maybe because they do not see the relevance of the material to themselves, their course or their career route or it was simply not what they expected. Students will only be motivated to learn if they value success and expect to pass (Jenkins 2002). Working with high-achieving students, Jenkins described how many students were not expecting the mathematically-based material on finite-state machines say, and, as in the current study, some students rejected aspects of course content. They did not understand, or accept, why they should master this material.

McGettrick *et al.* (2005) observed that the subject of computing has grown to be very large. They believed that the coverage of all material which would usually be deemed to be core was "*too complex and too crowded*" (*ibid.*:7) for an undergraduate degree. They believe that this could be one source of mismatch between students' expectations and experiences, and contributing to student withdrawal. It is certainly possible that even an entrant who had done significant research into the scope and content of computing, could meet surprises in their curriculum. However McGettrick *et al.*'s analysis failed to take account of the current range of computing courses in the UK – that many institutions already operate selectivity when designing the curriculum, not just in specialist computing courses, but also in Computer Science. Despite many such courses having long existed in post-1992 universities, they comment "*that there has to be a rich variety of programmes of study with different kinds of prerequisites and differing kinds of emphasis*" (*ibid.*:7). (All six authors were from highly-selective universities.) However the general thrust of their argument may be correct: that computing courses may try to cover too much and thereby place too much pressure on students.

As has been described, James initially rejected a module because he was not interested in it (§7.3.2). Other occurrences of students resisting parts of the curriculum encountered in practice, are of students who do not want to learn to program, since they do not want a job which focuses on programming, or students who are anxious about mathematics and do not see why they are compelled to study it. As already mentioned (§7.3.1), at Coventry University the

course regulations have very little flexibility and require students to pass these modules in order to progress (with only small opportunities for condonement). The course structure also forces students to take modules which can be inappropriate for their personal needs: their prior education might mean that they have already mastered the material. Sometimes, understanding the reality of the regulations, leads to a rapid, re-engagement. Sometimes though students do not take on board the significance of failing one or more modules until the end of the year when they find that they are not able to progress but need to resit elements.

The final level is disengagement from the course itself, although no interviewed student fitted this description. However a few such students clearly do exist and have been encountered over the years of professional practice. These students may simply realise that they are on the wrong course. This might include some of those students who applied for computing, expecting ICT (§6.4.1). Sometimes they may come forward and request to transfer to a different course. Sometimes, in talking to such students, it becomes evident that they are not enjoying their current course but may have no idea what they would prefer. Sometimes they struggle on but sometimes they simply drop out. Typically these students are hard to access since they may not respond to requests for discussions and are probably even less likely to volunteer to participate in a research project. In terms of attendance monitoring, these students are indistinguishable from those students who have circumstances which make attendance difficult by virtue of their health, personal situation or paid employment. However if a student has circumstances which prevent their attendance then it must often be difficult for them to remain engaged. Their motivation and commitment will be challenged and, without the reinforcement of attendance, it is easy to imagine that sometimes, maybe even often, their engagement will diminish over time.

100%	levels of engagement	0	disengaged from whole course (may be on wrong course)
		1	disengaged from the content of a few modules
		2	disengaged from the teaching process (differently engaged) (perhaps do not like teaching approach or timetable difficulties)
0%		3	fully engaged and committed

Figure 7-8: Levels of engagement

Thus, as illustrated in Figure 7-8, there appear to be a number of levels of disengagement, scales at which it can occur. A student may be disengaged from the teaching process for one or more modules; from the content of one or more modules; or from their whole course. In addition, it is clear from practice that disengagement can be of varying degrees. Indeed in many cases it may be more appropriate to refer to 'weak' or 'partial' engagement. For instance a student may be totally uninterested in a module but may still want to pass it, and hence they may submit work for assessment. However their disengagement from it might be total and they simply ignore module assessments, along with all other aspects of the module. Of course, there is a multitude of reasons why a student may miss a deadline other than poor engagement. It is not possible to know which, if any, of these forms of disengagement apply to an individual student purely on the basis of their non-attendance or their non-submission. The factors which can therefore be seen to influence student engagement are shown in a tentative force field model, in Figure 7-9. Some of these factors are well established, whilst others have been shown to be significant in this project.

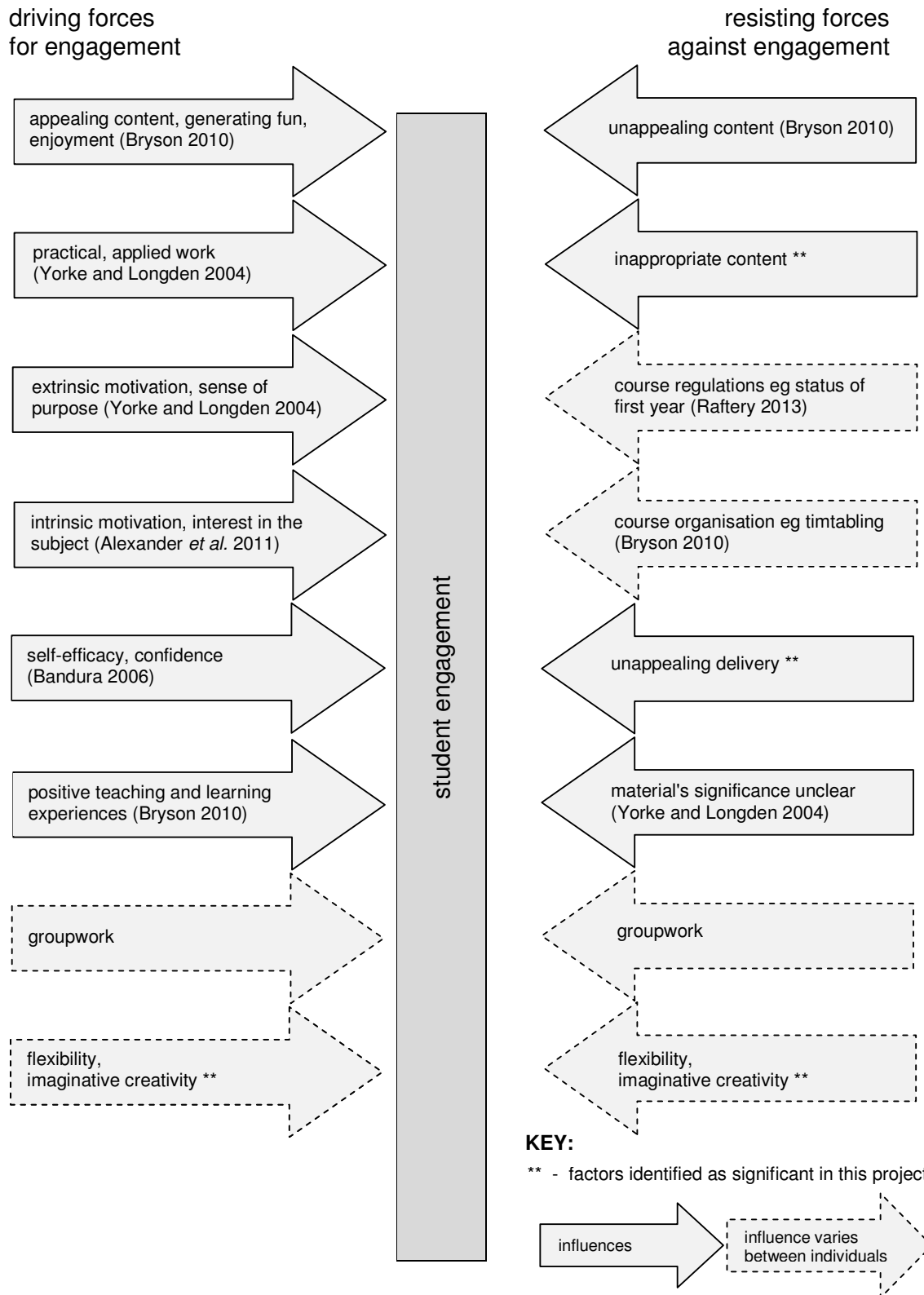


Figure 7-9: Factors which influence computing students' engagement

Looking at how these factors might have an impact on an individual student, some of them could influence a student's intrinsic or extrinsic motivation: two components of their engagement. For example, if they encounter material where the significance is unclear this might reduce a student's extrinsic motivation by challenging their conception of what the subject is about, whilst practical, applied work might enhance it. For those students who enjoy it, the opportunity to exercise their creativity might increase their intrinsic interest in the subject. As this research has shown, unsupportive course organisation for example can challenge a student's engagement, perhaps leading to that form of behaviour described earlier as 'differently engaged'. The motivations of such students are not necessarily affected though: the engagement aspect which is changed is how connected they are into their course, in a behavioural way. This can be termed 'functional connectedness' and can be considered to be a third component of a student's engagement. However underpinning engagement is the more general concept of emotion. Experiencing fun and enjoyment will tend to connect students emotionally into their course whilst unappealing delivery may diminish that connectedness. For many students working in groups can enhance their emotional connectedness, although for others it seems that it may impair it.

Thus, by considering how the factors which influence engagement (Figure 7-9) actually affect engagement, student engagement itself seems to present as a combination of four personal orientations, which collectively drive a student's connection with their university or course experience. These orientations are:

- intrinsic motivation in the course, and also in the subject itself;
- extrinsic motivation, consequent to course completion, which may generate a desire to succeed;
- emotional connectedness, including efforts at mastery and
- functional connectedness, which could in turn be considered as comprising a number of separate dimensions, such as attendance, submission, examination, catching-up online.

These orientations can sometimes have an effect in both directions. For example, a student with high intrinsic interest is more likely to respond positively if they experience unappealing delivery than a student where it is low. The former student may be relatively unaffected by it. However the latter student is not necessarily discouraged by it since they may be strong on some of the other orientations, leading to them responding positively too.

These orientations can be considered to be four separate dimensions, together comprising a profile of (dis-)engagement (represented as a tentative model in Figure 7-10). The arrow lengths represent the extent of each orientation possessed by an individual. For example, Figure 7-10(i) shows the possible profile of a single student, which may or may not be representative. (If it were ever possible to determine the relative significance of these dimensions, the arrow widths could be changed to reflect them.)

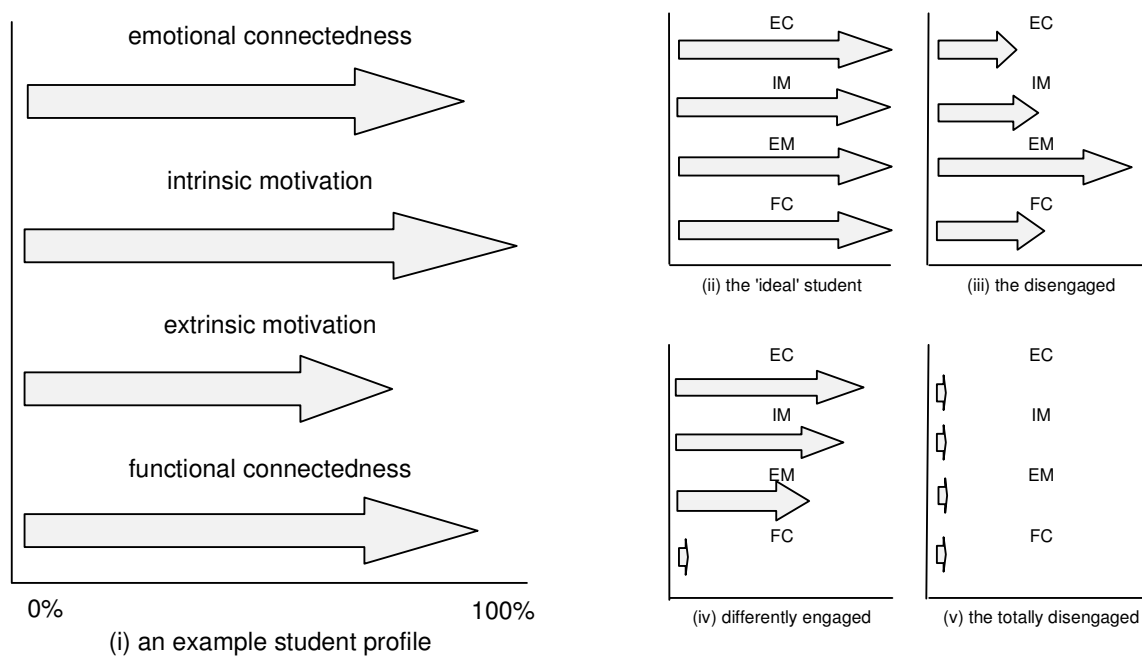


Figure 7-10: The dimensions of (dis-)engagement

Students each lie somewhere on these dimensions, although it would seem that some positions are more readily occupied than others. Whilst they are presented as four separate dimensions, they are not likely to be independent, in

the mathematical sense. There are probably inter-relationships between them. Figure 7-10 also shows four variant student profiles. The 'ideal' fully-engaged student's profile may be very high on all four dimensions and the totally disengaged student's is likely to be extremely low. The differently engaged student may have a low functional connectedness and high emotional connectedness whilst a disengaged student might have a low emotional connectedness. It is not known what relationship there is between the extent of connectedness and the extent of intrinsic and extrinsic motivation, but it may well vary between individuals. For example, whilst it is difficult to imagine a full emotional connectedness without a fairly strong intrinsic interest, perhaps a student might express a firm interest in the course without necessarily having an embracing emotional connection. The levels described earlier (Figure 7-8) relate to frequently populated locations on some of these dimensions.

It seems likely that a student's profile may change over time, moving along the axes as they become more (or less) engaged. Their position, and any such movement, will be influenced by factors such as their learning experiences and the appropriateness of material and its delivery, in the manner already summarised in Figure 7-9. This is discussed further in the next chapter. Additionally, a student's profile could differ across elements of their course: they may be very interested and engaged in some parts but uninterested and less engaged in others. They may have different measures of these four personal orientations when considered in the context of different course elements.

So what is disengagement?

So, what does this mean for student disengagement? Notwithstanding the comments just made, at one level, a dis-engaged student could be seen as one who is not engaged. However student disengagement can be viewed as a social construct (Bryson 2010). Frequently it is the term applied to those who do not conform to the social norms and requirements of their course. It can be seen as an identifier for those students who fail to make full use of the teaching and learning opportunities provided for them and are not functionally well-connected – for those students who fail to comply with the socially constructed

expectations. A lack of regular attendance is one way in which this view of disengagement can be discerned. However, much smaller events can also be viewed as reflecting such disengagement. For example, Price, Handley and Millar (2011) point out that many staff would believe that a student would be asking questions and attentively reading feedback if they were engaged, and they would therefore be considered to be disengaged if they did not routinely exhibit such behaviours. Thus engagement could be viewed as making full use of learning opportunities – being fully functionally connected.

Disengagement can be seen through structuring instruments such as attendance lists. Such lists, and management's responses to them, are direct attempts to change students' behaviour – to encourage their attendance. The gap on an attendance list can be seen as representing the 'irresponsible' student, one who is failing make use of their opportunities. However some of these students are simply exercising their agency, working against the structures of the course provision, and consciously deciding how they wish to engage. Nonetheless lecturers can be concerned that if students fail to use learning opportunities they are less likely to master the material.

However Dean and Jolly (2012) have a very different view of engagement, reducing the significance of compliance but foregrounding the importance of an emotional connection with the learning process (§3.5). From this perspective, as has been illustrated, it is not the students' involvement in formal learning opportunities which is crucially important to learning but rather their emotional attachment to, and their efforts to master, the curriculum. As is clear by viewing engagement as having four dimensions, this does not imply that a 'differently engaged' student is necessarily 'fully engaged' if they have this emotional connection, but it does adjust the balance of significance between compliance behaviour and psychological attachment. Some potential consequences of being labelled as 'dis-engaged' are considered next.

7.4 Responses to Presumed Disengagement

As has been explored, a student who is absent is not necessarily disengaged. James and John are both still engaged, at least to some extent. Sometimes students are emotionally still 'on board', and perhaps studying, whilst routinely absent from class. However students' academic progress is not the only issue of concern. Many universities compile lists of absent or potentially disengaged students in order to take action (NAO 2007). Chasing of absent students can be useful. In practice there have been many occasions when a student, who was sliding towards diminished engagement, came to appreciate the danger that they were facing when the extent of their absences was highlighted. However a student who is absent may not be amenable to simple appeals to attend. However their concerns, whether they are related to the course or not, might be addressed through an open discussion with an appropriate member of staff.

However the lists of absentee or disengaged students also exert power – they are not neutral and can have repercussions. In presenting these it is not to imply that monitoring is necessarily a 'bad idea', but to indicate that there can be unfortunate impacts. Monitoring may sometimes be the 'least bad' option although it is noted that some universities choose to emphasise the importance of learning, over attendance (NAO 2007). Two potential side-effects will be explored: those related to the infantilisation of students but first, labelling.

7.4.1 Labelling

Labelling theory was derived by Becker (2001) from his study of deviant behaviour – of the behaviour of people who fail to conform to the norms of society. Society 'labels' the deviants amongst it. In the current context whilst it is university staff who might label a student as 'absentee' or 'disengaged', rather than their peers, Becker's thinking is useful. Students who find that they are being identified in this way may see themselves as being 'labelled'. Whilst there is no evidence in this research of it occurring, the processes in place make labelling, and its repercussions, likely.

Students who see themselves as labelled as 'absentee' or 'dis-engaged' may believe that they are being identified as being deviant from the expected norm.

This could give them concerns for their reputation by being viewed as irresponsible. If they feel they have made a sensible, strategic decision they may consider this to be unfair and be embarrassed or upset by it. Pete certainly did not like the idea that he was being seen in this way and changed his behaviour 'just enough' to avoid such labelling. More damagingly, being labelled could become a self-fulfilling prophecy (Becker 2001). There is the risk that if a student believes their reputation is now damaged that their connections to the course might start to weaken.

Additionally, consciously, or not, staff may 'label' the student, expect less of them or see them as being less responsible, perhaps. This could be unfair on the student if they had been thoughtfully, 'strategically absent' or perhaps unwell. Staff, of course, need to be aware when students are exhibiting concerning behaviours and respond appropriately. But students may well see it differently.

7.4.2 Infantilisation

Another potential repercussion of monitoring is infantilisation. It has been reported (Sayers, Nicell and Hinds 2010) that students can resent attendance monitoring and see it as infringing their right to choose whether or not to attend. Pete was in his final year at the time of this research and subsequently graduated with a good degree. His attendance was influenced by whether his absence would be noticed. He attended if a register was likely to be taken:

Pete: *"Yes, registers are quite effective, because if there's a register then I'll more often than not go to that one, but if there's not a register I think, "It doesn't matter. Nobody will know I'm not there." "*

Interviewer: *"Don't you think it makes you feel, "It's treating me like a kid"? "*

Pete: *"Yes, but I think you need that sometimes."*

Interviewer: *"Well, that's honest. [...] But the other thing I also see is that you get students [...] walking out and there is all this other disruption. You're thinking, well what's that achieved? They've turned up and signed their name and they've still not engaged."*

Pete: *"Yes, I've done that a couple of times [...] but only in very rare times [...] I'll just walk out if I'm not interested..."*

Interviewer: *"But you've turned up to do the sign-in. Why?"*

Pete: *"So I don't get in trouble, but I don't have to stay in the lecture"*
(Pete-1#528).

Pete was exercising his agency, breaking the norm of attendance and yet doing what he saw as being enough to avoid 'trouble'. But he also recognised the power and influence that attendance registers had on him and that their use can be seen as infantilisation.

The situation with Pete may have arisen, in part, because the students' responsibilities were not made explicit. However Pete was clearly aware that attendance was expected but did not see any point in attending, beyond complying with the administrative requirements. Classes can only operate effectively if all parties are clear about, and maybe even explicitly agree on, respective expectations and responsibilities including, typically, attendance at class. A student who attends classes regularly may be exercising their agency to do so – they have actively decided that they want to or as an unthinking habit and response to cultural norms – or they may simply be present in response to the structural pressures of the attendance list and fearful of the administrative consequences of absenteeism.

There is a dilemma here though. As Macfarlane (2012:27) comments: *"attendance and punctuality are [...] important workplace competencies"*. However these behaviours need to be developed by the student for themselves, rather than be forced upon them, if they are to: *"develop the positive capability [...] to make choices as independent adults"* (*ibid*:27). Where attendance is closely monitored: *"students are treated more as naughty untrustworthy schoolchildren than young scholars"* (*ibid*:27). A balance is needed here: a balance between ensuring students are aware of expectations and their responsibilities and of excessively monitoring students, infantilising them and diminishing their professional development. Sufficient structure needs to be in place in the academic processes to guide students through their courses' core requirements, and to reduce the likelihood of irredeemable problems occurring, yet the students need to be left with significant agency so they can develop to be able to make well-considered, responsible choices. It is a very delicate balance.

This is particularly important since, as was discussed in Chapter 6, many pupils progress through their schooling having to make very few choices, and even fewer where the consequences seem significant.

As well as impeding student development the compilation of lists of absent or disengaged students can lead to other problems. Staff can be chasing students whose motivation does not warrant it, or at least not in the manner that can occur. Sometimes this can simply be a waste of effort, although the students involved might see this as infantilising. If they have made a mature, considered decision not to attend a particular set of classes they may resent being chased, but they may also resent the 'label'.

7.5 Conclusions

This chapter has explored students' experiences of their courses. Engaged students comment positively on aspects of the course they see as being fun, or maybe exciting. This is to be expected, of course, but nonetheless some interesting findings emerged.

- In this computing context, the term 'creative' is sometimes interpreted as referring to 'production' but at other times to 'imagination'. This is a potential source of misunderstanding.
- Some students were enthusiastic about the flexibility they are afforded by the open-ended, loose briefs that are issued for some assessments, which permit them to use their imaginative creativity.

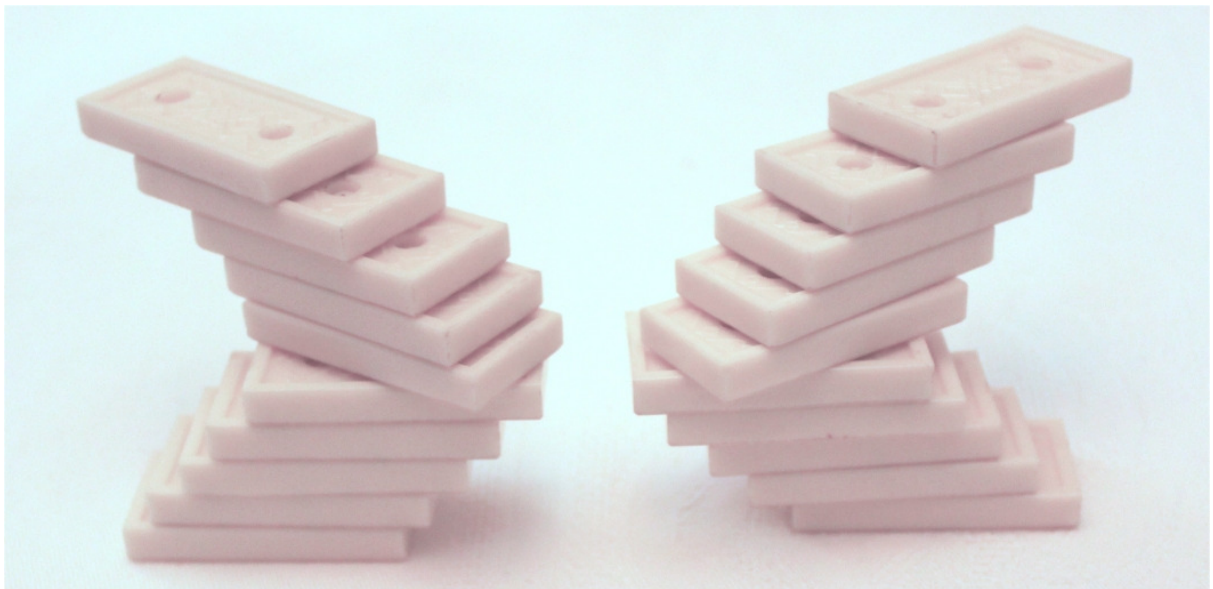
Whilst this imaginative creativity is not aligned with the way much of the IT industry operates, the potential to exploit it in course design, and the mismatch with previous research, are explored in Chapter 8.

- The wide range of student backgrounds means that they have a diverse range of needs. At Coventry the course regulations do not readily address this but expect some students to take modules which are not suitable for them. This has implications for student disengagement and, potentially, for student satisfaction.
- The use of instruments, such as attendance lists, can be a powerful structuring force. Whilst they can affect students' agency and encourage attendance, they can be both misleading and could damage relationships. At best such data should be treated as a proxy, being indicative of possible disengagement.
- Absentee students are not necessarily disengaged: they might still be well-connected with their learning and 'differently engaged'.
- Disengagement can vary in its extent and degree. A student might be disengaged from their entire course but they might be uninterested in, and disengaged from, specific modules, or even just from the formal teaching processes provided for specific modules.
- Three tentative models of engagement have been proposed:
 - a model identifying four distinct levels of engagement (Figure 7-8);
 - a model of the factors which influence engagement (Figure 7-9); and
 - a model of student orientations which, as four dimensions, together form a profile of (dis-)engagement (Figure 7-10).
- Different patterns of engagement reflect different causes and it would be most effective if staff responded accordingly. Of course, since the root causes are not generally readily evident, this would be far from easy to achieve.

Some of the implications for course design and management, of these disengagement issues are explored in the next chapter.

- The course regulations for first year students at many UK universities, in which the first year marks are not included in their degree classification, fail to encourage a sustained effort. Some students may be encouraged to engage better if they were made more aware of how learning works and that computing is a cumulative subject, in which subsequent learning builds on earlier foundations. However this point will not be explored further.
- Some students see their course as just the amassing of marks and credits. They do not seek to, or expect to need to, join a learning community. The implications of this for the student's learning, course management and the academic community are discussed in the next chapter.

8 : How does it stack up?



The Revealed Stacks

"This is what I make of it all" (Wolcott 1994:44).

8.1 Introduction

This project set out to explore the influences on students' perceptions of computing and the implications for HE in England. The background context and initial research objective was discussed earlier (Chapter 1). Themes emerged as work progressed, which led to the evolving research questions, which in turn served as the foci for investigation. These questions were to examine how students perceive the image of computing as a subject and profession; the factors which lead students to choose to study a computing course at university and what leads to some computing students to seem to be disengaged from their course. Thus, the preceding chapters have looked in turn at the three themes: the image of computing, student choice and, finally, student engagement. This chapter will explore these further, 'interpreting' those findings and considering what we now know and where we are now with our understanding: considering how it all stacks up. The subsequent, final chapter will consider the wider implications of this research, which are relevant to a range of stakeholders. Some of these implications arise from issues discussed in this chapter and some from the next, though they will all be presented together, in the final chapter. Areas for potential future work are mentioned through both chapters.

This chapter serves a number of purposes. Primarily it provides a discussion of the substantive contributions to knowledge generated by this research. A number of implications emerge from these discussions. This chapter is structured around the research questions, looking in turn at young people's perceptions of the image of computing; how they decide whether to choose to study it; how they engage with their studies of it and lastly the over-arching question of the influences on students. These sections are followed by a review of the theoretical lenses employed, discussing their usefulness as analytical devices. The contributions to the theory of ANT are described there. However this chapter commences with consideration of the theme of image: looking at how young people perceive the subject of computing.

8.2 Image

One theme of this research was image, which evolved into the first research question as: *"How do young people perceive the image and nature of computing as a subject and profession? This includes how they relate to computing personally and the stereotypes of 'nerd' and 'geek'?"* The stereotypical image of computing, often described as being 'nerdy' or 'geeky', is a powerful one and it seems almost inevitable that it would influence the appeal of the subject and profession. The primary contribution to knowledge from this theme has been, through the collection of empirical evidence, to confirm the deterrent effect of the geeky stereotype and some of the less direct ways in which that image of computing can have an impact. Of course, although not all students are deterred by the stereotype, this does highlight the importance of creating a more appealing image of the profession.

The term 'geek' is seldom described, let alone defined, and no attempt will be made to define it here. However it would usually be taken to refer to a set of personality attributes (such as social skills, dress sense, obsessiveness, attention to detail and technical expertise), each forming a spectrum, with people in IT ranging along the various axes, as would people in many other professions. However there are perhaps positions in this multi-dimensional space where IT people would tend to cluster.

Previous studies (for example, Pau *et al.* 2004, Mitchell 2005) (§2.6.3) asserted that the geeky image of computing deters some potential applicants. The current research gathered empirical evidence which confirms this deterrent effect.

Through the lens of Structure-Agency, the structuring effect of the geek label can be seen as denying some potential applicants the agency of application. Some participants confirmed that, in their personal experience, the image of computing had deterred some potentially-successful applicants. Of course this is not a deterministic effect – they were not debarred from applying – but the imagery invoked by the stereotype had exerted a strong deterrent effect on them and they did not want to be associated with that identity.

However the Structure-Agency lens also identified (§5.5) that the term geek is used in a range of ways, with diverse significations. Some participants were clear that it is not being referred to as a geek which matters in itself for them, but rather the intent of the speaker. This supports Bell and Corner's (2011) suggestion that the term is sometimes used light-heartedly, with the immediate impact of the word mediated through the manner of its use. Such usage does not however preclude a longer-term, insidious impact.

Bell and Corner (2011) also suggested that the term geek now attracts students more than it repels (§2.6.3). However the current study found no evidence for this. There is currently a 'geek chic' fashion trend (§5.5.1) but it is not clear that it is anything more. It might be that geeks are (re-)claiming that label, but none of the participants fully embraced the term. A few (for example, Chris, Martin and Justin) did acknowledge that others refer to them as geeks, and were comfortable, and perhaps even proud, to discuss this. Justin described how he realised that this conferred recognition of his specialist skills but saw it as something of a compliment dressed up as an insult. However none of the participants seemed to really own the term.

It is interesting to wonder had more of this data been collected in private, rather than in larger meetings, if these individuals would have discussed it differently. It could be a reflection of ego, suppressed for reasons of social etiquette, that they were reticent to be seen to own the label and yet very happy to volunteer its attribution to themselves. This suggests that maybe they had some hesitation and guardedness about 'coming out' publicly with regards to their geek identity. Whilst it did not seem to be the case, it is just possible that their restraint was feigned and they actually are proud to be regarded as geeks. They certainly valued the implied cultural capital. Nonetheless the over-riding sense was that those participants who were highly knowledgeable about the nature of computing – the '*cognoscenti*' – were accepting of the geeky stereotype and identity, although with reluctance with respect to some aspects. While not fully accepting the term geek they were very happy to identify with those aspects of the term which imply that they are particularly skilled, whilst rejecting the associated inference that their social skills are poorly developed. Thus this project provides

no evidence to add support to Bell and Corner's (2011) assertion that the geeky image of computing currently attracts more students than it discourages. Nor does it provide any support for Hewner and Knobelsdorf's (2008) finding that some students are excited to embrace computing's geeky image.

The less knowledgeable students also recognised that the geek stereotype exists (§5.5.1) but gave no indication of personally, currently identifying with it or that it was an identity which they anticipated that they would be expected to acquire in the future: that it was designated (§3.7) (Sfard and Prusak 2005). Mostly, they probably realised that they would need to work out how they wanted to present themselves in their new course – how to fit in – creating a new external identity (Wenger 2000). However they expected to be able to study computing without turning into geeks: they expected to be able to create a new identity for themselves and not for some unwelcome identity to be assigned to them. They saw the geek stereotype as being a reflection of only a portion of the profession, and not an identity which they would have to adopt. As shown by Solomon, Lawson and Croft (2011), working with mathematics students, whilst designated identities can be quite binding, it can be possible to escape them and create alternatives. Most participants in the current study expected to be able to do just that – to be able to choose how to present themselves.

It would be a useful project to investigate how pre-teens, and teenagers much younger than those involved in this research, view the image of computing and in what ways that affects their propensity to ultimately pursue this direction.

Research on the paucity of women in IT (for example, Margolis and Fisher 2002, Pau *et al.* 2004) shows that, for a number of reasons, girls are deterred from computing from a very early age. It could well be that the negative stereotype might have an impact very early, on both genders, and interventions would need to be targeted accordingly.

As described earlier (Chapter 5), this project provides evidence that computing has an incorrect external image and many people do not know what computing encompasses. This supports similar findings from many previous studies, such as those by Mitchell (2005) and Cutts *et al.* (2007) (§2.6.1). These earlier

studies are of work with school pupils where it was found that pupils often report not knowing what the study of Computing, or Computer Science, would be about. The current project provided similar, supporting evidence. It also provided evidence of this lack of understanding being prevalent in society generally.

The views of outsiders can be important. Considering the structuring force of this image of computing it is unsurprising that some people would choose not to exercise their agency to get involved. Many people would not want to work in a profession which was viewed so negatively. They may care about how others might perceive them and would not wish to be associated with such an identity (§5.5). They do not want to become what they think computing people are like. Some people try to avoid saying, in social situations, that they work in IT – Michael being an example in this project – in order to avoid being immediately associated with negative stereotypes. Computing is unlikely to be unique in this regard: other professions such as law and accountancy may well suffer similarly.

Considering the evidence from the perspective of identity made it clear that some participants, even some first year students such as Michael (§5.2.4) and Innocent (§5.2.2), were very comfortable to identify themselves as being insiders – as computer scientists. They were clear that this was their future career and they had assimilated it as part of their core identity although they recognised the problems that outsiders can have in understanding the subject's character and nature. However, from an egotistical stance, they also sometimes 'othered' (§5.2.4) students who are really struggling to master the subject matter. They were not at all sympathetic to their difficulties. This highlights that the computing classroom risks being an uncomfortable place for struggling students. Teaching staff need to be aware that displays of misplaced boasting in the classroom could be dispiriting for others and need to find ways to alleviate any tension, balancing the ambiance.

A number of studies (such as CPHC 2006, Mitchell 2005, Mitchell, Purchase and Hamer 2009, Pau *et al.* 2004) report that pupils see computing as 'boring' and as a result choose not to study it (§2.6.1). The current research encountered confirmatory reports of such views. As well as sometimes being conflated with

ICT, Schulte and Knobelsdorf (2007) identified that CS is sometimes assumed to refer to computing support work. However there are at least two issues involved. It is obvious that not everyone would find computing work to be interesting. Even given a 'fair' trial at such tasks some people would simply not find them to be enjoyable in any way. This is not a profound point, merely that different people find different things interesting. But, as this research makes evident, many outsiders are misinformed: they do not have the cultural capital of understanding which might allow them to understand or appreciate the appeal of computing. Of course this is not unique to computing, there are many activities that outsiders find difficult to understand. For example, it is hard to understand why anyone would want to go potholing and yet some people clearly enjoy it. But knowing more about its nature – maybe it is more than squirming on your belly, through mud, in the dark – could assist in understanding what others see as appealing and worthwhile about it. In a similar manner computing is frequently either not understood or misunderstood as being ICT or perhaps, as implied by Schulte and Knobelsdorf's (2007) work, technical support and its appeal judged on that basis. If outsiders had a better understanding of the tasks and issues which arise in computing they are more likely to see its appeal and the profession might be more attractive.

This supports the conclusion of both Mitchell, Purchase and Hamer (2009) and Adya and Kaiser (2005) that pupils are rejecting computing as an option, despite sometimes being aware they do not really understand what it is. The implication of this is that if more pupils understood what computing was about, some of them at least, may not dismiss it as being 'boring'. As discussed later, of course there will also be some pupils where the reverse is the case. They may be quite interested in computing (thinking it is ICT) but may not be remotely enthused by the reality.

The Grand Challenges Conference (McGettrick *et al.* 2005) noted the importance, to the future of computing, of promoting a positive image of the subject and profession. As already noted (§2.6), other authors (such as CPHC 2006, Shadbolt 2007, Yardi and Bruckman 2007b) have made similar comments. Implications #1 and #2, directed at professional bodies, suggest that they could

take steps to actively market the profession, presenting a more positive, personable image. The BCS currently provides some careers materials on their website but more could be done to convey, to the public, a view of what working in IT might involve.

As further research, it would be interesting to investigate how students and new graduates would describe the substance of computing to school pupils. The nature and content of examples they employ could provide a model for more effective marketing and pupil career guidance.

The remaining aspect of this research question is participants' impressions of the IT profession and workplace. As discussed earlier (Chapter 5), this research confirmed that even enrolled students know very little about IT careers. Many participants had chosen computing based on subject interest, rather than based on any knowledge of potential career prospects. Indeed the impressions they had of the IT workforce were often incorrect. Discussion on this matter was largely confined to first-year students, towards the start of their course. Despite this timing it is remarkable how very little most participants knew about IT employment. Whilst previous research has shown that the perceived nature of IT employment was a deterrent for some young people, the current work serves to highlight the limited information on which such views can be based. Since this particular group of participants were students who had already enrolled on computing courses, the paucity of their knowledge was particularly notable.

Many participants in the current project choose a computing course for reasons of interest rather than career opportunities. However that does tend to conflict with previous weakly evidenced findings (§3.6.1) which suggested that computing students, whilst being intrinsically motivated, are more strongly extrinsically motivated. Evidence from practice suggests that a healthy earnings potential is a prime motivator for many computing students. This area would merit further exploration.

The lack of knowledge about the workplace is probably true of many other career areas. However if more people are to be attracted into IT more information needs to be available to young people (Implication #1). Thus, in addition to

professional bodies working to adjust the public view of IT, universities could assist students' employment prospects by exposing them to a range of employment-related information (Implication #8). Also, presenting similar materials to potential applicants at Open Days might help more pupils select a computing subject as their application choice.

So, it seems apparent that students' perceptions of the image of computing, as a subject and profession, are highly influential in choosing to study it. Students, mostly, have a very limited awareness of computing overall and employment issues in particular. A large proportion are enrolled because of a personally-generated engagement and excitement with the subject. Typically such students enjoy the challenge of tackling a new computing problem. However, some are much more neutral and participants reported that a minority of their fellow students had failed to understand the nature of the subject at all. In general although participants are aware of the negative geeky stereotype of IT, they have chosen to get involved despite it, avoiding accepting some of those characteristics into their identity. The wider implications related to identity are explored in the next chapter.

8.3 Choice

The second main research theme was the choice process. Whilst image was clearly important, it became clear that multiple other factors were also influential. Thus the second research question, which evolved on this theme, was: *"What factors lead school pupils to choose to study a computing course at university? This includes the extent to which it is an active choice and the sources of advice and information which they use."*

The choices within making any application to university are the result of the applicant exercising their personal agency. On occasion they may be under coercion to apply to a particular university or for a particular subject, although this was not detected in the current research, but usually an application is the result of the applicant's agentic behaviour. However all applications are the

result of the effects of the structuring forces surrounding the applicant, in part conferred through the explicit support and guidance offered by those around them. However there are other more subtle influences at play too. Expectations and life-long suggestions and suppositions can constrain a youngster's agency and their habitus will affect how they respond. This could operate to encourage or discourage application, or their application for a particular subject or type of university.

The first contribution which this research brings from the choice theme, is confirmation of the largely anecdotal recognition that many pupils have an incorrect understanding of the likely content of those courses, often believing it to be ICT. This is frequently asserted as being the case but without any direct empirical evidence (for instance CPHC 2009, Cutts *et al.* 2007, Lovegrove and Round 2005, McChesney and Alexander 2006b). The current project provided some confirmatory evidence of this. Mitchell (2005), working with school pupils, also found many pupils conflated computing and ICT. However she also found that, when prompted, some older pupils did at least believe that they might differ, although they did not know what CS might encompass. Many pupils simply do not possess the cultural capital necessary to make an informed choice. This research has shown that such misinformed choices are also sometimes made by pupils who do apply to university to study computing. If all pupils are to have the opportunity to judiciously choose computing, then they must have some awareness of what it is.

It was notable though just how little research many participants had undertaken before making their choices. A few had delved into course descriptions in prospectuses or websites; one or two had looked at various university performance league table but most had done very little to explore their options. Almost all the pupil-participants had visited university Open Days but, of course, that was where most of them were recruited into the study so this may not be typical. For many the choice was as to which university they should apply, rather than which courses might suit them best. However, many pupils have had limited experience of making educational choices where there is scope for significant, direct repercussions if they get it wrong. As a result, as this research

has indicated (§6.3.1), a proportion seem to treat the choice-making processes quite lightly, perhaps not appreciating the potential significance of making a mistake. They may even behave like a Pooh-stick and be passively taken along by events (§6.6.6). The structures around them were leading to them making course applications; they were less powerful in encouraging them to carefully research their options. Issues associated with student recruitment are discussed further on Chapter 9.

The result of this is, as this project found, that some students do not know what to expect in their course and are sometimes surprised by its content. Previous studies have asserted this (for example, Boyle, Carter and Clark 2002, Cutts *et al.* 2007, Lovegrove and Round 2005) although none provide any empirical support. Of course the surprise that students express might sometimes be positive but it seems more likely that it will typically be neutral or negative. Whilst there is no reason to think that computing students pay less attention to such matters than those of other subjects, with the diverse content of computing degrees, sometimes even degrees with the same title, and the, sometimes, conflation of computing and ICT, the consequences of making a weakly researched choice may be greater for computing than many other disciplines. Students may be faced with material they did not expect and does not interest or suit them and they may become disillusioned or dissatisfied.

That this conflation is a significant structural barrier to computing recruitment is quite well known (for example, Mitchell 2005, McChesney and Alexander 2006b) (§6.4.1). This concern is compounded by a recent policy change that schools are now in charge of providing individualised careers advice to pupils, which might prove challenging for some schools. Implication #19 is that these school staff need to understand the difference between computing and ICT so as to better guide pupils' choices and Implication #2 suggests that Professional Bodies consider producing suitable resources to support them in this task.

One rather surprising finding from the current project follows from this conflation. This research showed that some people see study for a computing degree as pointless and worthless (§6.6.5). Lovegrove and Round (2005) asserted

something similar: that computing as an HE option is sometimes viewed as "*low prestige*" (*ibid.*:6), in comparison with mathematics or physical sciences.

Similarly, Lang (2012), in Australia, found that computing can be perceived by pupils to be "*low status*" (*ibid.*:291). However both these studies also reported that pupils have very limited awareness of possible careers.

The status of computing and IT work, of course, depends upon the particular aspect which is being compared, and with what. A network technician, programmer, project manager and database analyst – to name four somewhat differing computing roles – perhaps have different prestige and statuses. Comparing any of these with manual or semi-skilled work would perhaps lead one to conclude that IT is high status. However comparison with high-prestige professional occupations, of perhaps law or medicine, may lead many people to a different conclusion.

However, neither Lovegrove and Round (2005) nor Lang (2012) were suggesting that computing was seen as being worthless or pointless. However if people believe computing is a continuation of (the worst of) school ICT, then such a view is perhaps understandable. It would simply be a training programme for computer super-users. From this project it is evident that sometimes people do imagine a computing degree to be just that sort of skill-focussed subject (§5.2.2). It probably does not need saying, but all computing degrees, including those few with the title of Information Technology are very much more rounded and more technical than that.

Confirming computing as a valid, rigorous, well-founded academic subject was a major theme of the Royal Society (2012) report. The intended recipient of that message was primarily the Government and, along with other recent sources of pressure (§2.2), has led to a number of changes planned for the English educational system. Principally, these aim to get computing teaching into schools by amending the National Curriculum and by funding schemes for the training of new school teachers of computing. This will tend to help with raising the awareness of the nature of computing and is discussed further, later (Chapter 9).

Currently, most pupils do not get exposure to computing through standard educational processes and structures. The second contribution emerging from the choice theme was that pupils who do develop a reasonably accurate understanding of what the technical subject of computing is about, had almost all gained this understanding through some out-of-school, social connection, such as a parent or friend (§6.4). That parents can be significant in choice-making and providing encouragement to apply for a specific subject is probably commonplace, and for computing is already known (for example, Carter *et al.* 2009, Mitchell 2005, Royal Society 2012). The significant addition from the current research, is that social capital in the form of personal contacts, such as parents, are currently often the prime source of exposure to the content of technical computing. The benefit brought through such a contact often extends beyond a simple awareness of the subject. They bring cultural capital which can influence the nature of the guidance received and can lead to an enthusiasm for, and interest in, the subject through the opportunities and experiences available. The exposure to computing technology, ideas and principles which this minority of youngsters can gain through such contacts gives them the opportunity to be interested in and excited by computing. (Of course this would also be true for the professions of some of their other contacts.) However for many of the current generation of youngsters their social structures, both domestically and at school, do not give them any exposure to computing. As has already been described, even many enrolled computing students had a very limited and sometimes incorrect understanding of what computing is about and the kinds of careers that this could lead to. The lack of capital here, in the form of knowledge and awareness, is leading to some making ill-informed choices. Raising public awareness about the role and purpose of computing (Implication #1) would assist here.

The nature of computing as an academic subject is, in a world with computing all around us, surprisingly hard to explain and for outsiders to understand. In part this is because even subject experts find it hard to agree on what it is (§2.4.1). However that debate aside, the breadth of modern computing makes it evident that choices must be made by course designers (McGettrick *et al.* 2005), both in

the development of specialist courses but also in the design of courses with mainstream titles, particularly Computer Science and Computing. The consequences of this are that potential applicants will see the same degree title presented by different universities in very different ways. Indeed an academic from a Russell Group university, participating in the preliminary study for this project, observed with some irritation that different universities offer different content for a course title. He was particularly piqued that other universities were offering a Computer Science degree which he did not think merited that title. In part this is a feature of marketing activity, and indeed providers of degrees in many subjects would look for ways to present their provision as somehow different (§2.4.1). For applicants, the resulting range and diversity creates a structural complexity which must make understanding the core nature of the subject itself somewhat problematic, although offering them choice.

The diversity in curricula must cause recruitment complications, with employers being unclear about the skill set they can expect from individual graduates. Conversely, as has been described (§6.5.3), individual employers sometimes specify very detailed and precise job requirements which may not fit many institutions' curricula. However, quite reasonably, McGettrick *et al.* (2005) pointed out that graduates need to have high levels of skills which should be of use to employers. Whilst McGettrick's comment was based on the need for students to have technically up-to-date skills it may well have been informed by the reputation that some elite institutions' courses are very theoretical, with students undertaking very little by way of practical work (as described earlier §2.4.1). It could be argued that graduates from such courses are ideally prepared for some areas of theoretical research but may be poorly prepared for careers in IT *per se*. These tensions, and the implications for graduate employment and employers recruitment difficulties, are explored in the next chapter.

Not all applicants realise that universities set their own curricula, meaning they are less likely to investigate specific courses with particular care. This would matter rather less if the content and purpose of specific courses was more evident to applicants. As the state of much course information stands it must be

hard for a curious pupil to gain a fair understanding of the nature and scope of the subject and particular courses (Implication #5). There is a recent professional skills framework (SFIA) (BCS 2011b) but this focuses on generic, rather than technical, skills so could not be adopted to help. Also, universities need to be sure that the students they recruit really do want admission to the type of course they apply for. Ideally students should not be surprised by significant elements of course content. Implications #9 and #12 both relate to trying to ensure that students enrol on courses which better suit their interests, for both the universities' and applicants' benefit.

So overall, what factors impact on a pupil's decision as to whether to apply for a computing course at university? The biggest factor relates to the social and cultural capital which they possess and the social structures in which they live. These will determine if they have been exposed to computing and have an understanding of its nature. On a practical level, it is obvious that the pupil needs to decide that they want to progress to university with all the associated implications and perhaps that decision is sometimes inextricably intertwined with the decision about which subject to study. Maybe they have already developed a passion for the subject such that applying for a computing course is natural. However sometimes this might be an enjoyment of ICT and they may apply equally readily. As discussed, whilst there could, and maybe should, be more and better information about course content and subsequent employment, what is notable is how little advice and guidance many participants actually made use of. Whilst applying for university is always something of an act of faith, a few participants behaved with little agency, but like a Pooh-stick nudged into the river, although they failed to realise this. This situation is likely to apply to many disciplines: there is no reason to think computing applicants are less diligent than others in this regard but the consequences here could be very significant. If you apply for computing thinking you are applying for a different type of course you may become a very unhappy, dispirited student indeed.

8.4 Engagement

The final major theme, and the driving force and rationale for the research, was to understand the dynamics of disengagement in computing students. This theme evolved into the final research sub-question as: *"What leads some computing students to seem to disengage from their course? This includes the factors which affect engagement and how disengagement is represented."*

In chapter 7 (§7.3.5) three models of engagement were proposed. The dimensions of (dis-)engagement (Figure 7-10) shows the four components which comprise engagement: extrinsic and intrinsic motivation and emotional and functional connectedness. Students, in their various ways of engaging, can be seen as being positioned variously on these dimensions. The model of factors which contribute to engagement (or disengagement) (Figure 7-9) shows the influences which can relocate students along these dimensions. For example a positive learning experience can increase a student's engagement by increasing their intrinsic interest in the subject. Conversely unappealing content, say, might decrease engagement by diminishing emotional connectedness, perhaps. The model of the levels of engagement (Figure 7-8) shows four common positions for students: fully engaged, disengaged from some of the teaching process, disengaged from some of the content and entirely disengaged. The reasons for disengagement will, of course, vary between individuals, in varying combinations of the influencing factors identified in the second model (Figure 7-9).

These three models are presented tentatively and require testing for applicability in other contexts. However they form a contribution to the conceptualisation and understanding of engagement. The dimensions and the levels of engagement models are novel. Many authors have presented lists of factors which influence engagement (for example, Bryson 2010, Dean and Jolly 2012, HEA 2012b, Trowler 2010). However the model presented here includes some factors which seem to be newly identified. These three models could perhaps be useful in course management. For example the dimensions of (dis-)engagement model may assist in diagnosing the situation of individual students. The factors model might provide ideas for routes for improvement (Implication #11).

Previous research has used the idea of dimensions in the context of investigating engagement. Bryson (2010), in reviewing previous work on engagement, refers to engagement as being multi-faceted, depending on who or what students are engaging with. Fredricks, Blumenfeld and Paris identified three dimensions in engagement: emotional, behavioural and cognitive engagement (Trowler 2010). The model developed in this project could be viewed as an extension of that one. Buckley (2013), as a means of validating the survey instrument, analysed the results of a pilot application of the internationally-adopted National Survey of Student Engagement (NSSE), in England and Wales. Statistical analysis of these results showed four separate aspects to engagement: critical thinking, course challenge, collaborative learning and academic integration. These overlap with the dimensions identified in the current study, although functional connectedness is not addressed in the survey.

Previously (§3.5.1), three models of student engagement were presented: Yorke and Longden's Theory of Student Departure; Bryson's Sources of Engagement and Lent and Brown's Model of Engagement. These have been drawn into discussions at various points, calling on the diverse concepts they include. No attempt will be made here to integrate them into a single model. Similarly no attempt will be made to modify these models either. They were presented in the form of cause and effect diagrams to facilitate reference, based on the authors' text. The authors may have presented them differently if they had drawn them themselves, perhaps adding additional elements or connections. Nevertheless, this project found supporting evidence of many of the connections in the models, and nothing to contradict them. However, none of these models reflect the finding that some students can be 'differently engaged' with their course.

That some students can become regarded and labelled as being disengaged when this is not appropriate, and they may be better considered to be 'differently engaged', is the second contribution to knowledge from this engagement theme. This novel idea has practical implications since such students could suffer inappropriate and unhelpful experiences or interactions with staff as a consequence of such mis-labelling (§7.4).

The experiences of some students of their courses are not always very positive (Chapter 7). The excitement and engagement expressed by some is not a universal experience. How they respond to their course experiences will depend on their expectations but also their habitus and how they view education more generally. Some fail to attend all elements of their course (§7.3.2) and, as this research showed, many of those may be identified as disengaged when they are not. A proportion may be 'differently engaged' (§7.3.5): engaged in some way different to that intended by the course designers and behaving in a way which can be perceived to be inappropriate and deviant. Previous generic work on disengagement, for example that described earlier (§3.5), has been to look for its causes and sources. In computing, most work has been to look for factors which influence students' success or retention and to identify that poor engagement, sometimes identified through absenteeism, as being relevant (for example, Livesay, Alexander and Boyle 2003, Ruslanov and Yolevich 2010, Sayers, Nicell and Hinds 2010). However it has assumed that a student who was habitually absent was, to some degree at least, somewhat disengaged and either lacking interest or being strategic in where to make their efforts. However, as this research shows, absence can, for example, reflect a student responding to a situation where their course really does not fit their personal needs.

The generic models of engagement presented earlier (§3.5) were looking for such causation. None of those models reflect the situation of the 'differently engaged', which is consistent, since these students were broadly engaged. For such students, their time and physical and emotional energy may be directed towards their learning, as in Dean and Jolly's (2012) definition of engagement (§3.5), and yet they may not be attending classes. These 'differently engaged' are some of those students who lie at disengagement level 1 (Figure 7-8), disengaged from aspects of the teaching process. For these students the course was structured in such a way, in terms of content or delivery, as to cause them to use their agency to absent themselves from class. This might be because a course regulation requires students to enrol on unsuitable modules or a mode of content delivery which they find unhelpful. These are some of the factors identified as impeding full engagement (Figure 7-9). This is not to suggest that

all of the factors which resist engagement can, or do, lead to the behaviour exhibited by the 'differently engaged'. For example, a student who is influenced by the status of the first year in the calculation of their degree classification is more likely to be strategic in where they apply their diminished effort, than to work hard but unconventionally. Considering the 'differently engaged' student against the dimensions of characteristics of engagement, it is possible that they have a strong intrinsic and extrinsic motivation to succeed and a good measure of emotional connectedness, despite not being functionally well-connected.

This attention on 'differently engaged' students is not to suggest that all students who are less engaged than might academics wish are somehow 'differently engaged'. The preliminary study identified that all of the diverse institutions involved have some groups of students, on at least some of their computing courses, who are less engaged than the academics felt was desirable, only some of whom are likely to be working in an unconventional manner. Some of the sources of weak engagement at Coventry University have been identified and, whilst these issues will not be unique to Coventry, it is likely that the detail may be different at other institutions with different course structures, regulations and monitoring mechanisms. Likewise most of these issues will not be unique to computing courses.

The way in which disengagement can be addressed is, of course, to focus on the factors which can lead to it (Figure 7-9). This does not necessarily lead to easy solutions. However in this project one particularly problematic area was found. As has been seen, the current course structures require students to study material which is far below their current level, and therefore so unsuited to their personal needs, that it is not helpful to the student or module team. Students should not routinely be asked to study material which is so unsuitable. This stems from a structural problem in that all students are regarded as having the same needs: a 'one size fits all' model of HE.

The structuring effects of different regulations in different HEIs will allow them to use different strategies to address such concerns. Some universities may be able to offer differentiated material to students. For students who already have

adequate knowledge of a topic, an approach which could be applied at Coventry University, and many other institutions, is through the use of Accreditation of Prior Learning (APL) regulations (Implication #14). To assist students whose Mathematics is weak (and perhaps those who lack mathematical confidence) an online, pre-enrolment, revision course could be considered, the passing of which could be a condition for enrolment (Implication #6). This would permit the course itself to start delivery at a higher level. However, as the Lent and Brown model (§3.5.1) identifies, it is important for engagement and success that students expect to succeed. This would mean that significant support would need to be given to the weaker students and differentiated Mathematics modules may be helpful to fast-track those who enter with more advanced skills. However it is crucial that students, perhaps particularly those lacking in confidence, appreciate the significance of the material they are being asked to master since, as both Yorke and Longden (2004) (§3.5.1) and Jenkins (2002) pointed out, this is important for engagement. (It is probably unrealistic to suggest a similar pre-enrolment provision for *ab initio* programmers since it can be very difficult to get started in programming without any direct support and would probably be off-putting for many.) As Powell (2008) suggests, differentiated modules for programming too may help support students where there is a diverse range of backgrounds.

Consideration of engagement through the ANT lens made it evident that participants saw computing in a wide range of ways, but perhaps as a challenge or exciting (§5.2). The second contribution in this theme relates to the value of flexibility, choice and creativity for some students' enjoyment of computing activities. Creativity, provided through flexibility in some learning activities, was a very positive feature for many, although not all, participants (§5.2.5, §7.2.2). It enhances students' choice and agency in their work but reduces the structuring imposed. This benefit of flexibility in computing courses has not previously been noted. For those many students who enjoyed it, having flexibility enhanced their experience and, in line with Bryson's engagement model (§3.5.1), supported their engagement. Whilst flexibility is a feature of some work at Coventry it is not

known how prevalent it is in computing degree courses elsewhere: it may be quite unusual.

The potential benefit of creativity for enthusing computing students has not been previously recognised. Indeed the literature (for example, Lovegrove and Round (2005), Yardi and Bruckman (2007a)) reports that one of the problems with the image of computing is its lack of creativity. However most studies report on work with school pupils, who will typically not be studying Computing, and could be responding with respect to their experiences with school ICT which is sometimes reported to be quite mundane. There seems to be no previous research which looks at attitudes to creativity in enrolled computing students. It was surprising quite how significant creativity and flexibility were to some student-participants – both some on mainstream computing courses, as well as those on 'creative' ones. This is a useful finding. That 'creative' (imaginative) can sometimes be confused with 'creation' (production); that the appeal of creativity could usefully be exploited and that the mismatch in character with much work in the IT industry needs to be managed, have all already been explored (§7.2.2). Nonetheless designers of computing courses in HEIs could consider how they might exploit the appeal of flexibility and creativity (Implication #7).

Computing courses are unlike those in some other disciplines, in that they are not predicated on an emotional engagement, and therefore a deep involvement risks being seen, by both staff and student, as, in some senses, optional. A few students, most notably James and Pete, saw the course as being simply the completion of all their assessments. As long as they achieved decent marks in these nothing else seemed to matter and from a course progress perspective they are correct. Courses are often structured such that these separate assessment marks alone directly determine the final degree outcome. Such a regime forms a powerful structuring force which supports any student who chooses to adopt such a strategic view. James was clearly not seeking any form of attachment (§7.3.2) and there were several other participants who also clearly had no sense of emotional attachment to their course or university.

Instrumentally, all were very keen to successfully complete their degree, but they sought no other form of attachment. In professional practice, sometimes it

appears as though students reject the articulated, valued competences of their course, exercise their agency and behave as though they know better. For example they will decide for themselves what content they see as being important. They reject the espoused norms and do not want to engage fully. They may remain on the course (since they still aspire to gain the qualification) but remain on the edge of the community, retaining their own fixed and separate identity, distanced from most, if not all, of their course cohort.

However the literature is clear that students benefit from having an emotional connection with their course and its teachers: it is recognised as being a significant factor for learning to take place (HEA 2012b, Northumbria University 2011, Pierson 2013, Ramsden 1998, THE 2009, Trowler and Trowler 2010). This is Tinto's social and academic integration, referred to by Bryson (2010) in his sources of student engagement (§3.5.1). Dean and Jolly (2012) are clear that it is not a student's compliance which matters – their functional connectedness – but their emotional connectedness with their learning. This is as suggested in the proposed model of dimensions of (dis-)engagement (Figure 7-10) which implies that attention should be paid to whether students are learning and are emotionally engaged, rather than their attendance, with the risks associated with that (§7.4). As already mentioned (§7.4), some universities do focus on students' learning and are much less concerned with their compliance (NAO 2007). This zone for attention is shown in Figure 8-1. Such an approach could also diminish the perverse effect that the course regulations

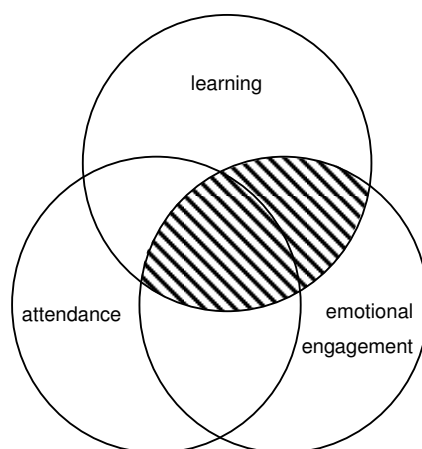


Figure 8-1: The zone for attention

can have on some first year students, making it less likely that they reduce their efforts.

In suggesting this, caution needs to be exercised. This engagement literature does not distinguish between different types of students. Computing students might differ from the student body more generally, although that seems unlikely. However it is possible that such approaches are more suited to the academically stronger and more confident students and that some less confident students might respond in unhelpful ways.

Developing emotional integration can be seen as the creation of social capital in staff and, more particularly, students which can then be drawn on as necessary to smooth over lumpy events or ease communication or underpin understanding based on mutual trust and cooperation. Hence the development of the emotional ties of staff-student relationships with all students, but especially with students such as Pete and James, might form one element of the route to improving engagement generally. Of course this is not to suggest that Pete and James would not succeed without such deepened engagement but this literature suggests that their outcome might be improved with it.

For students to feel connected to their course it needs to be welcoming and appear relevant (§2.4.6). Students need to feel accepted. The importance and potential effects of friendship and peer group has been discussed previously (§7.3.3). Powell (2008) notes that where students feel part of an academic community they are more likely to feel confident and to persist with their course. However the course experience must not seem to be cliquy or excluding. No matter what the student's habitus or cultural capital, even if it is different to the institution's norms, they need to feel they belong, otherwise they may be inclined to withdraw (HEA 2012b). Cultural changes, previously described (§2.6.2), at Carnegie Mellon University (Margolis and Fisher 2002) were to allow female students feel more accepted and led to improved retention rates. However the presentation of full, complete emotional engagement will vary between students, since it is an individual social construct (Bryson 2010). It is important that the student sees that they are expected to get involved, rather than it being some

peripheral, optional extra. Their experience must be embedded within their course and it should endeavour to satisfy the needs of every student (HEA 2012b). To find this, students need to feel that they belong and to be part of a community of staff and students (Implication #4).

At Coventry the Computer Club provided such a community for those students who had the confidence to attend. It provided a focus for staff and students to work together on off-curriculum projects simply for the pleasure, excitement and curiosity of doing so. However the students who attended this were highly knowledgeable and saw the club as an opportunity to show-off, challenge and provide some degree of support for each other. The culture was one of 'boys with toys and egos'. For these able students it was a positive experience but, as Carl described, it was daunting for those with less confidence or knowledge. This club does not provide that accepting source of engagement needed by students.

For students to be able to gain from an emotional engagement with their course they first need to recognise that there is a group of staff who deliver at least most of their course and they need to feel that they relate, at least in some ways, to a proportion of that group. This will not have all of the qualities of a CoP or community of learners (§3.8), but it should be an identifiable community nonetheless. As has been described, the literature indicates that students need such a group to pay some interest in them as unique individuals, with their own interests and aspirations: to form a human connection. They are looking for *"some middle ground between a distant formality and an inappropriate friendliness and [students] describe this ideal in terms of a mentoring or coaching relationship"* (Northumbria University 2011:7). This would mean that they feel they are genuinely welcomed and belong. *"Belonging is critical to student retention and success"* (HEA 2012b). They would see themselves as part of their course and would know who to talk to about aspects of it. Of course it is not viable for all staff to deal with every student in this personal and individual way all the time but opportunities can be found, or made, which recognise the student as a human being and which present the human face of staff. Some approaches to this are in a Good Practice Guide to Learning Relationships (Northumbria

University 2011). It is recognised, at least by some, that both staff and students may need help in developing their capacity to engage (HEA 2012b). It is not always a pre-existing skill. By recognising the humanity involved, a better relationship will be formed, one which gives and expects respect and acknowledgement and one which can foster better learning. These relationships are important. By paying heed to their development, social capital will be formed and motivation enhanced, probably in both staff and student (Northumbria University 2011). There are opportunities for some action research (Trowler 2012a) to explore the impact of such initiatives.

So by way of summary, a partial response to the question: "*What leads to some computing students to seem to disengage from their course?*" is that sometimes apparently disengaged students are simply studying in a way different to that expected by their course designers. But also, there is an overriding impression conveyed by some students of detachment from their course. A few seem to see their degree as simply a series of hurdles to be jumped. This must be unhelpful to their personal learning particularly by missing opportunities to learn both from and with their peers and staff. Ensuring that there is a sense of community, with appropriate professional relationships between staff and students, is important in addressing this. These points have wide applicability and are likely to be relevant beyond computing courses and Coventry University.

8.5 Influences on Students

The overarching question which evolved to guide this research as a whole was: *What influences students' choice, perception of, and engagement with, computing courses and what are the implications for Higher Education in England?*, to which this section will respond.

Young people's perceptions of computing vary widely, which is not surprising as each individual has been subject to diverse events and influences through their life. A number of principal points have emerged from this project. Young people are largely ignorant of the nature of computing, often believing that 'computing' is

ICT, as experienced at school. This misunderstanding can lead to the misperception that computing is not a credible degree subject. Alternatively young people base their perception of computing as a profession on stereotypical depictions from television and films where, almost invariably, the identity presented is of someone who is skilled but antisocial. Even if 'geek' is 'chic' only a few youngsters would probably find this appealing. This is significant because often young people have no alternative sources of information. It was notable how seldom careers staff or careers information played much part in participants' career choices. Participants' comments indicate that some careers staff do not have an accurate-enough understanding of the substance of computing themselves (Implication #2).

The school pupils who do have a reasonably accurate view are those who have been subject to particular influences. Some participants attended schools where computing was actively promoted. In a very few cases the school offered both ICT and Computing at A-level and teaching staff might actively promote these subjects, trying to ensure that the differences were clear. However, most participants who had a decent understanding of the nature of computing, had gained this through their friends or, more usually, family. Their life experiences had led them to develop cultural capital which embraced computing. However this essentially excludes many pupils from judiciously choosing computing for their future.

Although image and choice were important starting points for this project, perhaps the most significant area proved to be student dis-engagement. Once enrolled on a computing degree, as has been shown, students' engagement is influenced by a very wide range of factors. A student's personal orientations interact with features of their course and its management. Social issues involving the relationships with friends, fellow students and teaching staff all influence the nature and extent of a student's engagement. It is a complex, broad-based set of influences, the understanding of which led to the three models of the characteristics of engagement discussed earlier (Chapter 7 and §8.4).

This research specifically considered issues, as they apply in England. Despite not aiming to claim any degree of generalisability, findings here should be broadly transferable across England, although possibly not to the most elite institutions. The engagement findings are likely to apply to very many disciplines, especially those where student backgrounds vary widely. Findings are likely to apply as much to females as to males. The issues related to schools will vary depending on the school's speciality and status. Whilst care was taken during analysis to take a broad view and avoid taking a middle-class perspective, at the educational extremes the position will be somewhat different. In some disadvantaged schools university enrolment is still unusual, whilst at elite private schools the 'privilege' acquired through the associated social capital can only be imagined. With these limited caveats, it is likely that the findings here will be broadly applicable across England.

The precise form of manifestation of matters concerning recruitment, course choice and student experience in a university computing course will depend on course content, marketing and the degree of selectivity exercised by course recruiters. For example some of the small, locally-recruiting, post-2000 universities seem to be very effective in engendering a friendly, embracing atmosphere which would profoundly influence the students' experience. However the preliminary study showed that computing academics across the spectrum of institutions in England encounter disengaged or misguided students (§4.4.4). Nonetheless it would be a useful future study to work with other institutions to ascertain the range of applicability of these findings. This would permit the identification of any differences and allow national initiatives and activities to be better targetted.

The computing issues identified in this research probably apply across the whole of the UK too, although the detail of the educational system varies between the four nations. Indeed much of the previous research was conducted in Scotland. It is likely that many of the issues discussed will resonate in other Anglo-centric countries as well. Certainly similar issues have been raised in Canada and Australia (for example, Lang 2012), and are the subject of substantial research in the US (for example, Hewner and Knobelsdorf 2008, Carter *et al.* 2009).

However it must be acknowledged that these are not universal concerns. Some parts of the world expose their pupils to significant amounts of technical computing, most notably programming. This difference figured in this project through the very different views and opinions expressed by students from Eastern Europe (in particular Bulgaria and Romania). Those participants had significant expertise in computing but also they had not experienced any negative stereotyping in their home countries. In those countries technical expertise and education seem to be well-respected and valued. There are certainly opportunities for further work in comparing the situation in England with that in other parts of the world, looking for commonalities and points of difference. This could lead to the identification of lessons useful for the UK.

8.6 Reflections on the Conceptual Framework

The final requirement of this chapter is to review the value gained from conceptual framework and its theoretical lenses. The discussion presented thus far in this chapter has raised a number of substantive issues which could only have been addressed within a qualitative study. The limitations of a quantitative study to investigate issues such as these have already been discussed (§4.2): a qualitative, interpretive approach was much more informative. Whilst other lenses could have been adopted into the framework the selected combination served this project well.

ANT, through AADs, provided the prime lens for analysis, helping to identify interesting points and connections. That, with supported by the other lenses (TSP and Structure-Agency), served a dual role. As well as helping to identify additional issues they also helped to deepen the understanding of the issues that emerged: exploiting the explanatory power of these theories. This was substantially an iterative process. Data and emerging ideas were explored using ANT with the other lenses used in different ways, at different points, in order to delve deeper into the issues. At no stage did the lenses give contradictory views but rather their insights supported and complemented one another. First the value of using the ANT lens will be reviewed, and the associated theoretical

contributions highlighted, before moving on to Structure and Agency and the Theory of Social Practice.

8.6.1 Usefulness of Actor-Network Theory

Actor-network theory initially appealed for use since it can help investigate how entities influence one another. It therefore seemed relevant for a project looking at the influences on students' course choices, particularly its facility to include both human and inanimate entities, of any scale. The most valuable aspect of ANT was the focus it encourages on actors and their associations, which can form hierarchical networks of influences (for example 'university', in Figure 6-13).

That there could be a graphical representation of these associations seemed clear, since its rhetoric invokes visual imagery. The consideration of entities and related associations were familiar being the kind of thinking necessary for database design. The idea of trying to reuse one of the entity-relationship diagram (ERD) styles seemed obvious. The resulting AADs proved very useful and this novel diagramming approach is the first substantive contribution related to ANT.

The act of creating each diagram forces the systematic consideration of which entities are in a network and the modelling of the relationships between them. Appropriate notational conventions were derived for each type of entity: fixed, 'immutable mobile'; changeable and fluid; or an optional, fire, 'absent presence' object. It became apparent that sometimes the associations between entities also had interesting characteristics and hence that these too could be fixed, fluid or fire and the diagramming conventions were extended to these. This is a useful addition in that it forces the consideration of the optionality and durability of relationships, separately from the entities which they connect. The process of representing associations led to the recognition that it can sometimes be useful to model multiple associations between a pair of actors (for example, between family and student in Figure 6.1). The explicit consideration of the relationships in this way extends the ANT concepts in the literature, forming another contribution to Actor-Network Theory.

Most entities and associations identified were fluid and change slowly over time. Some entities were seen to be relatively fixed and immutable, such as the school curriculum and option structure (Figure 6-5). It was this and the identification of some objects or associations as being optional, that led to useful insights. For example some school option structures offer computing, but others do not; some pupils were supported and guided by careers staff, but others were not (Figure 6-5). This approach allowed the messiness of the real life to be represented, reflecting the diversity of experiences and situations of different individuals.

AADs proved a useful diagramming notation which can assist with the operationalisation of aspects of Actor-Network Theory. However, whilst they were useful for documentation and giving support to the narrative, that was not their main benefit. It was through the process of creating the diagrams that understandings were developed, forcing the detailed consideration of the interacting entities and their relationships. AADs could be used in very many situations where relationships and influences between entities were of interest. Indeed one of the useful features of ANT is that it can be used with all kinds of entities and is not restricted to the animate. Used in this way ANT could be seen to be a method rather more than a theory *per se*. It provided an analytical tool, although there are theoretical elements embedded within it. Certainly, in this project, the explanatory power of ANT came through its use as a method.

Sometimes ANT is considered to be an ontology (for example, Larval Subjects 2009). Both of the other main theories adopted also offer ontologies, providing other ways of viewing the world. They differ in so far as Structure-Agency and TSP are restricted to the consideration of the social world whilst ANT allows for the consideration of any entities, physical or conceptual, as well as the human. They also have differing ranges of scales. ANT is very flexible in scale, although here it tended to address the individual, as did TSP. Agency is in essence a concept applied to an individual although the structures which work to influence it can operate at a range of scales. Thus, together, these lenses allowed a range of types of influences on individuals' course choices to be investigated. The benefits and insights gained from using Structure-Agency will be discussed next, followed by those from Social Practice Theory.

8.6.2 Usefulness of Structure and Agency

The concept of agency, and more frequently structure, were useful throughout the analysis leading to the recognition of many large-scale issues across all of the main research themes. This lens showed that some of the structural issues of computing employment affect the image of the subject and thereby pupils' agency to consider it as a career option. The most evident was that the image of computing professionals as often being geeks forms a powerful structuring force impeding the choosing of computing (§5.5). Other issues related to the perception of the profession, such as gender balance and age profile, operate in a similar manner (§5.3). The structure of school education; restricted option choices and the limited exposure to computing in schools (§6.4.1), all reduce pupils' (and students') agency to choose to study computing. The structuring forces in schools are so strong that the school educational system was even likened to a conveyor belt, drawing pupils to apply for university entrance (§6.3.1).

The behaviour of a minority of students in university is so lacking in any apparent sense of personal agency, emotional engagement or personal responsibility that they were likened to Pooh-sticks, being passively taken along by events around them (§6.6.6). The structure of degree courses can be seen to be problematic, both with respect to students taking inappropriate modules and in first year marks not 'counting'. In both situations this led some students to exercise their agency in ways which they see as being tactical and almost inevitable – "*Why should I attend if I already know this?*" or "*Why would I work really hard if the marks do not count?*" – but academics would tend to see this as being inappropriate (Chapter 7). Computing tasks were sometimes so loosely structured that students were afforded flexibility and agency in their completion, which many welcomed (§7.2).

Another area where structure and agency proved valuable was in considering the linkage between universities and employment. The poor alignment between universities' curricula and some employers' recruitment wishes is a significant structural matter which directly impedes students' ability to secure employment

(§5.3, §6.5.3). This limits some students' agency to apply for some graduate posts when they do not fully satisfy the employee specification. It is possible that, if encountered frequently, this might cause students to question and maybe lose confidence in their curriculum and could be a source of dissatisfaction. This might merit further investigation.

Structures were identified throughout the analysis, some of which were restricting and some enabling. It is relatively easy to recognise the limitations imposed in a context but to overlook the structures which are facilitators of agency as being just part of the background. In exactly the same way structures are much more readily identified than agency: they are simply more obvious. Bourdieu observed that structures are often foregrounded in research, above agency. He suggests that this is because they give the impression of being objective, whilst agency appears subjective (Calhoun 2000). Experience in this research suggests that structures are simply more obvious. By using Structure-Agency as an overt lens it ensured that both aspects of the duality were considered during data analysis. However, alongside power, this lens also brought two additional aspects of social structures: norms and meaning. These provided yet more routes to discerning processes, influences and impacts during analysis.

8.6.3 Usefulness of the Theory of Social Practice

The adoption of Social Practice Theory, principally capital and habitus, as the third main lens also proved useful. Like Structure-Agency it provided an insight into some of the social constructs which influence course choice, often those smaller in scale, offering a finer-grained analysis. Focussing on social and cultural capital made it evident that pupils' knowledge of what computing is about and IT employment opportunities is usually a consequence of who they know, rather than any structural events and processes in school or life generally. Focus on habitus also made it evident that in some families, aspirations and expectations are set high. This certainly affects some students' university applications. For some the choice is as to where and what to study rather than

whether to apply. The education conveyor, powered in part by family habitus, is leading most capable pupils to see university as the natural next step.

A focus on human capital and habitus made it clear that students are still developing into adults. They are less likely than adults to understand why things matter or how things work. Some are still very naïve. Their family habitus and expectations affect their aspirations and the norms they tend to adopt. However, as they develop with a group of peers, together they generate group norms and a group habitus. This can be positive and supportive but for some groups the developing norms can be unhelpful to the goals and aims of the students' course. For example, it is clear that group norms can sometimes lead to group absenteeism or collective attendance. Groups develop their own norms and values, collective ways of being with each other which also impact on their external interactions. Thereby groups will tend to engage collectively with their course, or not.

The TSP lens was useful in delving into social issues which affect the individual: individual's capital, individual's habitus and so forth, extending a little to consider peer group issues, such as group habitus. It permitted the identification of drivers and constraints on individual's actions and attitudes. It highlighted the impact of social and human capital on an individual's life choices and opportunities, most evidently that the majority of pupils are never exposed to technical computing and therefore never really have the opportunity to consider it as a career route.

8.7 Conclusions

To summarise, this project provided confirmation of a number of issues related to computing students' attitudes, which are already recognised in the computing academic community as experiential, anecdotal knowledge, but which appear to have been little explored in the academic literature. Such issues include school pupils' poor or incorrect understanding of the content of computing courses and the influence of the stereotype of the 'geek', on the image of computing.

A number of fresh insights were made which form the main contributions to knowledge. These are, firstly, the crucial importance of exposure to technical computing, by parents or friends (or more rarely teachers), to pupils gaining a reasonably accurate understanding of what computing is about. The life course for many of the current generation of youngsters provides few opportunities for them to gain this awareness, although the National Curriculum changes discussed in the next chapter will radically change this. The geeky stereotypical image of computing deters some potential applicants. Secondly, flexibility and creativity are helpful for some students' enjoyment of computing activities. Some students can become regarded and labelled as being disengaged when this is not appropriate: they may be better considered to be 'differently engaged'. Finally, three tentative models of engagement are proposed.

In addition to these substantive contributions, a diagramming notation has been developed which can assist with the operationalisation of aspects of Actor-Network Theory (ANT) as an investigative tool. Also, it became evident when working with ANT, that consideration of the nature of the relationships between actors can be as revealing as investigating the actors themselves.

So, having summarised what we now know relating to the research questions and the contributions made to our knowledge, and appraised the benefits from the main theoretical lenses adopted, the final chapter will consider the broader implications for stakeholders of the issues identified.

9 : Looking Back and Forth



Coventry Cathedral: walking forwards, turning and then ...



... looking back reveals quite a surprise

9.1 Introduction

In the previous chapter I drew together responses to the core questions underpinning this research: the influences on how young people perceive, choose and engage with computing. However my prime motivation for this project was to discern why some computing students do not seem to enjoy their course, are not particularly successful and fail to thrive. My comments in this chapter emanate from my research project and discuss the wider implications. Rather more than the previous chapters they are informed by personal experience in practice and from an awareness and critique of changes and policy in this area. To acknowledge this more personal and direct involvement, I return to writing in the first person.

Computing degrees have some of the poorest levels of graduate employment (§2.4.5), even at a time when many employers report that they find it hard to recruit IT staff with the necessary skills. Whilst many of these vacancies would not be first-tier graduate posts, some are. If more computing students were more successful at securing graduate-level IT work the skills gap would at least be eased. Conversely, as I explained in Chapter 6, many pupils decide not to study computing, based on very slender information. Whilst this must be true of very many disciplines, some of these pupils would be very capable and find IT a rewarding area for a career. And some of those are girls, a group whose scarcity in computing is a chronic concern to many. If pupils were more informed about the nature and opportunities in computing, and therefore those who enrolled on computing degrees were more suited – if there were a better match – it would be a win-win-win position for the student, universities and employers.

I explored the issues surrounding my motivation to attract better suited students in earlier chapters. My purpose here is to suggest some broader implications and tentative ideas for action arising from this research. These are presented initially in summary form below (Table 9-1), for ease of reference. A full description is presented later (§9.5). During this discussion I will raise some ideas for future research. I will conclude this chapter, and my thesis, by

evaluating my project and with some reflections. I will consider some of the implications related to the National Curriculum changes planned for computing education in schools and then some structural issues related to university degrees. However I will start by considering the profile – the image – of computing.

British Computer Society	1	Work to change the public image of computing and the IT profession
	2	Investigate if there is a need for more materials to support careers teachers and advisors
University Lecturers and Course Leaders	3	Ensure students understand the relevance of topics taught
	4	Ensure that courses engender an inclusive learning community
	5	Ensure that detailed course content information is available
	6	Consider mathematics entry requirements and how best to support mathematically-weaker candidates, perhaps with pre-sessional work
	7	Consider if it is possible to exploit many students' enthusiasm for flexibility in their assessments, allowing students to use their imagination
	8	Ensure students are aware of the wide range of types of IT employment opportunities
	9	Endeavour to ensure that applicants are really aware of the nature of their course, maybe through interviews
	10	Courses need to be designed with employment requirements in mind
University management	11	Consider a policy of rejecting any applicants who have significantly misunderstood the nature and qualities of computing
	12	Ensure students have access to reasonably up-to-date and industrially-relevant facilities
	13	Courses should be designed to allow all students to build from their existing skills base and not assume they all have the same needs
Governmental agencies BIS, DfE, Teaching Agency	14	Extend STEM initiatives to include computing and IT
	15	The recent funding of scholarships and bursaries for the training of new computing teachers should remain in place long term
	16	Delay the introduction of the revised Computing National Curriculum to allow time for more skilled teachers to be trained or retrained
	17	Launch a publicity campaign to ensure computing students are aware of the new opportunities in teaching

Schools and Local Education Authorities	18	Schools (primary and secondary) and LEAs need to consider how they will meet the requirements of the new Computing curriculum
Careers staff	19	Careers staff need to be aware of the nature of computing employment and the skills required
IT employers (via Intellect and eSkillsUK)	20	Employers need to be as flexible as possible in their advertising and recruitment of staff

Table 9-1: Summary of implications for stakeholders

9.2 The Profile of Computing

Partially as a result of the profession failing to communicate with the public, computing has a fairly negative image (Chapter 5 and §8.2). As discussed in the previous chapter, computing people are imagined to be lacking social skills, obsessive and usually male. It deters potential applicants. This research found that many people have very little awareness of the diverse employment opportunities in IT. Indeed sometimes computing is assumed to be an extension of application use, as often experienced in school as ICT. With this perception computing can be judged as being not worthy of degree study. Image-making has been largely left to the vagaries of the media. Innovations are attributed to 'geeks' and TV programmes featuring people who work in the industry, most obviously *'The IT Crowd'*, portray employees as work-obsessed albeit clever people, who lack personal skills, or sometimes even common sense. Often they are the butt of the joke. Of course this is not a new observation (Chapter 5). I have attended more than one conference or workshop which has concluded that a step forward would be to find 'The Professor Brian Cox of Computing': someone who could be the face of computing to the public, presenting an appealing but authoritative front for the subject, who could convey a sense of what computing is about.

As already mentioned (§8.2), the '*Grand Challenges in Computing*' conference highlighted this poor image as the most important issue facing the computing education profession and, as has been seen, this emerged as a significant area of concern in this research. The conference saw the challenge as being to: "*promote an improved and ultimately very positive public image of computing, ensuring that the public gains respect for the field and the professionals who practice within it... [and to] develop metrics that provide a barometer of the health of computing*" (McGettrick *et al.* 2005:5). They proposed the establishment of a 'Computing Council' which could promote and oversee the wellbeing of computing – "*for the maintenance [sic] of a strong workforce*" (McGettrick *et al.* 2005:22). Similarly the Royal Society (2012) recommended the establishment of a 'UK Forum' for computing. There seems to have been no action to establish such a body, although the BCS has done some work in this area.

For some years now the BCS has been working to improve the standing of IT as a profession, mostly focussed on the reputation of the Professional Body itself and its members. However as the literature reports (for example, CPHC 2006, Ruslanov and Yolevich 2010 (§2.6)) and this research highlights, more is needed, aimed at raising the image and reputation of the IT industry *per se*. This project has shown that attitudes to, and conceptions of, computing start to develop at a young age. For many youngsters, their early exposure at school gives them a view of only a small part of computing (ICT) and a part which they may not find interesting. As this research found, typically they are not exposed to any intellectually challenging computing activities, which some pupils would find exciting and attractive. Schulte and Knobelsdorf (2007) make the very important point that the image is deeply embedded in culture and children are influenced by it very early. Therefore, as they highlight, misperceptions will not be corrected by simply trying to tell the public what Computer Science really is. This would alone not be convincing. The way CS is conceived – the public's worldview – needs modification. The changes planned for the school curriculum, discussed later (§9.3), may help to do that.

However the inclination to choose computing is affected not just by the young persons' personal conceptions of computing but also those around them or who advise them. Also, some young people would not wish to be associated with a career with a negative image, even if they believe it is not warranted. For these reasons it would assist appropriate recruitment onto computing courses if the general public, as well as pupils, had a more positive, arguably more accurate, perception of IT (Implication #1). One way in which the BCS is currently working to change the profile of computing as a subject and to address the skills shortage, is through providing significant support and input into the Computing At Schools (CAS) campaign group (§2.2). Issues related to forthcoming changes in school computing will be discussed shortly (§9.3).

In the UK, the term STEM (Science, Technology, Engineering, Mathematics) sometimes includes computing but often – maybe usually – it does not. Many government initiatives for STEM subjects exclude computing. On one level this is unsound. Computing is clearly central to STEM, drawing heavily on all four of the named disciplines. Indeed it is sometimes said that computing: "*is the silent 'C' in STEM*" (BCS 2010c). However, for example, the government's National STEM Centre for schools and the related STEM Cohesion Programme, to coordinate and enhance STEM uptake in schools, excluded computing (and ICT) (NFER 2011). The National HE STEM Programme, to support and develop STEM in universities, did likewise (HE STEM 2010). This is not quite as surprising as it may at first seem: school ICT became aligned with business rather than technology.

However the rationale for excluding computing from some STEM initiatives was probably, at least in part, because computing degree courses have historically recruited well, and hence did not need the additional support deemed necessary to boost the appeal of science, mathematics, engineering and the range of non-computing technology subjects. The Higher Education Funding Council for England (HEFCE) are reluctant to accord computing equal Strategically Important and Vulnerable (SIV) subject status as the other STEM disciplines (BCS 2010b, CPHC 2009). Some people have been concerned about the decline in the numbers of computing graduates for the last decade, although

there has been some recent improvement (§2.4.2), but while the absolute numbers of applicants and students have remained high, providing extra resources to boost recruitment has not been a government priority. However including computing within the STEM umbrella, and of course preferably with SIV funding, would help achieve a useful increase in the visibility of technical computing which, as this research shows, is rather lacking (Implication #15).

There was a recent escalation of concerns about the skills shortage in the IT industry, triggered by the NESTA report (2011), Schmidt's lecture (Schmidt 2011) and Royal Society report (2012) (§2.2). This has led to an explosion of interest and activity. Previous to these events the elevated levels of computing graduate unemployment, even during times of reported skills shortage, had often been attributed to inappropriate degree content and its uninspiring delivery, such that employers do not consider some graduates to be 'fit for purpose' (§2.4.5). This research found that highly specific employer requirements, which universities in general cannot satisfy, must form some part of this problem. A CPHC investigation into the elevated levels of unemployment of computing graduates failed to fully reveal the reasons (CPHC 2012) (§2.4.5). The student engagement issues identified in this project suggest that content which is inappropriate for that individual, and thereby impedes their progress, must be another factor in the employment situation. However, in addition, all factors identified in this research as impeding engagement, are likely to have the resultant effect of diminishing student learning and directly affecting their employment prospects. However students' weaker engagement will also probably influence how much they benefit from the less tangible opportunities and employability advantages which course enrolment can bring. For example, it is probable that a weakly-engaged student is less likely to discuss possible options with academic staff; attend employment fairs, or seek discussions of options and opportunities if they do attend; attend employer talks or get involved in computer clubs. It seems likely that such students would consider such extra-curricula activities to be just that – 'extra', thereby compounding their employment disadvantage. In support of this probability, in the current project

the only students who mentioned such activities were those who appeared to be highly engaged in all respects.

Also, the Royal Society decided to treat the official Higher Education Statistics Agency (HESA) unemployment data "*with suspicion*" (Royal Society 2012:27) for a number of reasons including the impact of loss of graduate posts offshore in recent years and the very broad categories used in the data analysis. They did not believe that the formal statistics provide an accurate picture of computing graduates' employment prospects. (A very similar argument could be presented for many other cognate areas.)

Whilst the experience of computing students at every university could probably be improved, this is likely to be the case for every discipline, and there is no reason to think that computing is poorer than most disciplines (Implication #3). However it is the case (§5.2.2), that computing degrees are not all particularly practical, and indeed this may not always be their aim. Also, as the preliminary study revealed, some universities struggle to provide an education resource base which is modern and sufficiently industrially relevant. This results in students who may, or may not, have a good understanding of the underlying computing theories, who may have limited practical skills but inevitably their skills will be in a restricted set of technologies (§5.2.2 and §6.5.3). Additionally, at least until recent years, not all computing courses paid much attention to developing students' inter-personal and professional skills. Cukier (2003), working in Canada, commented that the IT skills shortage is often articulated in terms of technical computing skills even though communication and similar personal skills are increasingly in demand, and seen as a weakness in some candidates by some employers (§2.6.2). However as this research illustrated, there can only ever be limited scope for satisfying the diverse desires of employers with regard to skills, both technical and otherwise. Thakurdas (2013) recommended that employers try to exercise flexibility in their recruitment and this seems to be crucial to addressing both the employment gap and computing graduate unemployment (Implications #10, #13 and #20).

The three events (publication of the Royal Society (2012) and NESTA (2011) reports and Schmidt's lecture (2011)) in particular, have moved the spotlight of concern into schools. As the current study has confirmed many, indeed probably most, students get no exposure to technical computing when they are in school and confirmed that this leads to many students applying for a computing course without having any experience which would lead them to understand what it is or to realise that it differed from ICT. There is no reason to think that this is a particularly recent phenomenon. Hence this leads to a multi-factored explanation of why so many computing graduates are unemployed in times of skill shortages, beyond any weaknesses in HE courses (§2.4.5). The influences which I believe are at play are summarised in Figure 9–1.

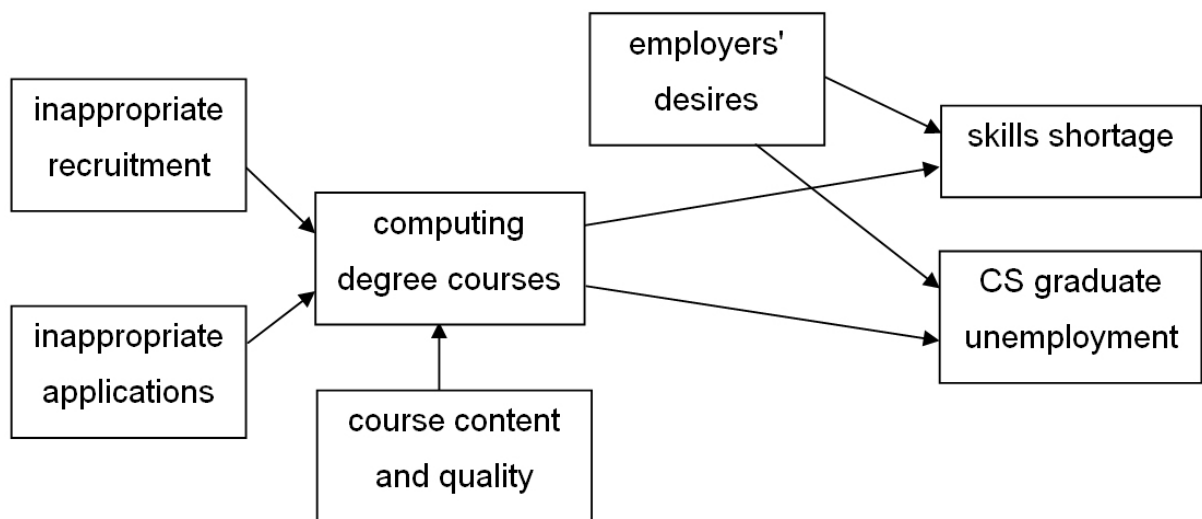


Figure 9–1: Influences on CS skills shortage and graduate unemployment

In presenting this I am acutely aware of my 'insider' status and that this may appear rather defensive. However I hope that it is clear that I think that there are several causes of computing students' relatively poor employment record.

This, and other research, shows that a sizeable minority of applicants seek entry to computing degrees based on a mis-understanding of their nature.

Universities, typically, do not interview applicants and hence make offers based on their predicted grades and personal statements (Implication #9). Sometimes

universities specify that particular A-levels should have been studied, maybe mathematics or a science, but very often they do not (Royal Society 2012). My preliminary study confirmed that at some institutions this is exacerbated by the pressure to recruit extra students during Clearing, further limiting the selectivity of recruitment, especially since many computing courses recruit many of their students at this time (§2.4.2) (Implication #12). Whatever the balance between them, this study confirms that the processes of inappropriate recruitment and inappropriate application have led to a sizeable number of students enrolling on computing courses who have only a limited interest in the material actually covered during their degree. On many courses the delivery and student experience may mean that such students might 'scrape by', stumbling to graduation. There may be aspects of their course which they enjoyed; there are probably others which they did not. Whilst it is not the only topic which can lead to employment difficulties, my practice shows that many students graduate with no interest, and limited skills, in programming (Implications #1 and #5).

I have discussed the reduction in first-level graduate posts due to off-shoring previously (§5.3) and this seems to have made entry to graduate employment harder. However when an employer recruits, quite understandably, they are looking for graduates who are capable, flexible and enthusiastic. For many employers, and for quite a lot of roles, an unwillingness to do any programming would be an insurmountable obstacle. This needs to be considered in conjunction with some employers' demands for specific, detailed technology skill-sets. However some employers realise that they can quickly train a graduate in the particular technologies which they use and they will consider graduates who have experience of something similar. However, it is still quite common for job advertisements to give extended lists of highly specific skills which they require (§6.5.3). Whilst this is understandable from tiny organisations, it is often an unrealistic expectation and diminishes graduates ability to fill the post, when there are candidates who could quite quickly learn to do the job if given a chance (Implication #20). This is probably a significant factor in the level of computing graduate unemployment (§2.4.5).

A university course can only expose a student to a small proportion of the technologies currently used in industry. However, for students to repeatedly see job advertisements seeking skills they will not be taught, must be dispiriting and make them query their employability post-graduation. Course organisers need to decide what to deliver based on pedagogical and practical concerns, as well as considering employment implications. But this also points to a difference of view as to the purpose of a university degree as to whether it is specifically about job training or should have a broader aim. Pragmatically a degree must be about exposing students to the subject in a way which develops an understanding of the enduring, underlying principles and the ability to move speedily into new areas and technologies. No other outcome is realistic, but this is not how employers necessarily view it or, as identified in the current project, some students. This is a very significant, structural tension (Implications #13 and #20).

Thus whilst universities could do more to reduce the computing graduate unemployment problem, and maybe some employers could be more flexible in their recruitment, both of which would help to alleviate the skills gap, the current focus of attention is moving back up the educational conveyor to schools.

9.3 Changes in Computing in Schools

The widespread lack of understanding of the nature of computing amongst pupils is central to many of the issues raised by my research and the changes planned for the school curriculum will have an impact. The Computing At School group has been instrumental in campaigning to get computing taught in schools (§2.2). As a direct result there are now (September 2013) many changes planned for schools. Computing has been accepted as a science in the definition of the English Baccalaureate award. From September 2014, across the whole age range, Computing will be the umbrella subject in the National Curriculum, with computing content replacing the current ICT focus (DfE 2013). This should bring improvement. There are very many consequences of this, so I will focus on the main ones only.

The changes will probably lead to most pupils at those state schools which are required to comply with the National Curriculum, gaining some understanding of the nature of computing. This should mean that most pupils will be able to decide whether to pursue computing based on some personal experience. As this research showed, few pupils currently get this exposure through their school. Those pupils who do understand the nature of CS have mostly gained this through their family or some personal contact and without such exposure pupils are not in the position to make a properly informed decision as to whether or not to pursue a career in computing. As this project showed, currently some pupils are making their selection based on their enjoyment of ICT and then finding it difficult to engage with their course. Whilst many organisations, particularly universities, currently organise outreach, taster and experience events these cannot ever reach any more than a small minority of pupils and cannot do more than give a brief exposure to the subject. The extended introduction intended through the revised curriculum is therefore very helpful in this regard. Pupils will cover computing concepts as a matter of routine in schools. These changes will, of course, mean that girls will be required to engage with technical computing until age 14. This will probably make some positive contribution to redressing the gender imbalance.

The revised National Curriculum focuses largely on technical computing. Even at age 5-7 pupils will be expected to create simple programs, by some means or other. Some pupils will enjoy this and find they are good at it and perhaps become the computer scientists of the future. Indeed, as this project found, a few pupils already experience this through the ICT curriculum. A few participants experienced an 'enhanced' delivery of ICT in that they had been exposed to technical issues and challenges (such as programming). However this is unusual and, as this research confirmed, more often, ICT is confined to the use of applications. Whilst these are important employment skills they do not convey the essence of CS. As I will discuss shortly, one result of this focus is that many ICT teachers have a business rather than computing background. This is problematic for the delivery of the new curriculum. However even if pupils have excellent teachers and support, exciting projects and resources, the nature of the

content means it seems likely that some pupils will struggle. Additionally, as I will explain, it is unlikely that all pupils will have good teaching and some pupils could be deterred from computing because of their poor school experiences.

The revised Curriculum focuses on Computing, at the expense of ICT. This may adversely impact on industry generally since very many jobs require a decent level of IT skills. Skills such as keyboard and online search skills will still be acquired – basic computer literacy should be secure – but skills with office and communication software may well be substantially curtailed. The current rhetoric is that ICT is repetitive and *"demotivating"* (Gove 2012). However, in terms of promoting computing as an appealing discipline, the new computing curriculum is a welcome opportunity. It will introduce most pupils to aspects of computing. The OFSTED (2011) report into ICT does point to duplication of material and the lack of excitement of many tasks set. However those are not arguments for the radical move away from ICT. Indeed OFSTED was very positive about much existing ICT teaching, particularly in primary schools and many participants in this project were very positive about their ICT experiences, even some who seem to have experienced a fairly typical delivery. The repetitive and uninspired reputation of some ICT work suggests that perhaps it could be made more appealing if students were given more opportunity to exercise their imagination and there was flexibility in the work set. This research showed that many computing students welcome that. However the requirements of the ICT curriculum may constrain this and might similarly limit teachers' flexibility within the new computing curriculum.

The Royal Society (2012) recommended three threads of teaching: Computer Science, IT and Digital Literacy (§2.2). This would have been much clearer – reducing scope for misunderstanding and helping to ensure pupils get the subjects they want. However, whilst it is understandable if the DfE do not wish to over-crowd the curriculum with three separate subjects, it is very unfortunate that they are not retaining ICT (or IT) separately, alongside introducing Computing (or CS). The DfE (2013) see computing as the umbrella term, in the same way that I am using it in this project. For example, there are currently GCSEs and A-levels in both ICT and Computing but it is not clear if the plan is to retain both subjects.

If both are not retained then, of course, it would limit pupils' potential choices. However, more germane to this research, it would risk pupils still misunderstanding the scope of computing courses and, by focussing on technical development topics, perhaps discourage applications to the more business-focussed computing degrees. This revised arrangement may still not help pupils understand the three distinct types of computing work, as identified by Schulte and Knobelsdorf (2007): user, designer and technical support (*i.e.* 'professional user'). Thus pupils might still misunderstand the nature and scope of computing, still conflating their perceptions but in a different way.

ICT suffers from often being taught by teachers who were not qualified in the subject (§2.3). Indeed, even of those who did gain their teaching qualification in ICT, many are graduates of subjects other than computing (Appendix F.2). It seems business graduates found this an accessible route into teaching and for delivery of the ICT curriculum this need not be problematic. However such teachers are unlikely to be readily able to deliver much of the new Computing curriculum. Too many Computing pupils may end up being taught by: "*a cohort of undertrained teachers*" (Brown *et al.* 2013:6). Since one objective is to make the computing curriculum more exciting and challenging this could be disastrous. Having teachers who are comfortable and confident in the subject is crucial to their delivery and pupils' experiences. These changes could so easily herald a return to the 1980's when the teaching of Computing as a specialist subject in schools received a damning report from Her Majesty's Inspectors of Schools (HMI 1990), being characterised as dull and boring. If teachers are lacking confidence in their computing abilities or find that they need to do too much innovation too quickly then their teaching could easily be mundane and uninteresting. If this were to happen then recruitment to computing degrees might be significantly damaged. Pupils' school computing experience could easily become a disincentive for further study. As this research has shown it is important that youngsters have positive early experiences of computing so that they develop confidence in their abilities and positive views of the subject (Implication #18).

Many people have recognised the problems here. The government has recognised the need for training and has changed its Initial Teacher Training to focus on Computing rather than ICT. They have funded bursaries and scholarships to support computing graduates to train as teachers. At the time of writing (June 2013) it looks as though very many of these places will go unfilled for September 2013. In part this will be because many computing students will not be aware that the teaching which is about to start in schools will not be (or at least should not be) the same as that which they probably experienced. For interested graduates this represents an opportunity to enter teaching at a time when there will be high demand for their skills. Alongside providing suitable teachers to develop the next generation of computer scientists, it will slightly improve the graduate employment statistics (Implication #16).

There are schemes to develop Master teachers to deliver CPD to existing ICT teachers (CAS 2012b) and accredited courses for those who need more. However very many computing teachers need to be trained very quickly if many pupils' experience is not going to be inadequate. If teachers lack confidence in the subject this will probably be conveyed to their pupils, potentially cultivating negative attitudes towards computing. As has been noted, this research highlighted the importance of these curriculum changes leading to positive pupil experiences and having adequate numbers of confident computing teachers must be a critical requirement for that. However it is hard to see that they can be developed quickly enough for planned timeframe (Implication #17). An interesting future project would be to monitor the changes in pupils' perceptions and attitudes to computing, especially those of pupils aged 10-16, say, as these changes phase in.

9.4 Computing Degrees and Recruitment

There are many varieties of computing degree, with some inconsistency in their naming (§2.4.1). This was raised in this project as being problematic. The inconsistencies make it harder for any pupil who looks at course details in an effort to understand what a particular computing area is about. More

significantly, this research found that some students enrol thinking that they know what their course title will encompass, only to be surprised by aspects of its content. This is very likely to be because they have paid very little attention to the relevant course information, another feature for which this project found clear evidence. In part, as was encountered in this project, this is a consequence of some students not realising that universities set their own curricula and therefore differ. Specialist degrees which are more focussed have been developed for niche market provision and, for commercial and customer demand reasons, are likely to remain. However the naming inconsistencies appear to be as prevalent on the more common titles, such as Computing or Computer Science, as any specialist title. They are unfortunate though and potentially problematic for the unwary student.

The BCS could adopt a policy of more tightly defining programme content for accredited courses. However during the process of defining the original computing Subject Benchmark Statement for the QAA, attendees at the consultative meetings which I attended in 2000, on behalf of Coventry University, were very clear that they wanted to retain the flexibility, and commercial benefit, of being able to create new routes as and when the need and market opportunities presented. The Benchmark Statement (QAA 2007) derived is therefore extremely loose and broad-ranging. Whilst this might be the best policy for the community overall, one consequence is, as this research has shown, that some students are confused about course content and meet material they were not expecting.

Some essential course content can be alienating to some applicants and hence Computing course developers may find various ways of including it, somewhat covertly, to avoid scaring off possible candidates. Mathematics and programming are the most obvious cases where content is sometimes packaged under a different label. This can obscure the nature of the content but can be a means to motivate the student to engage with the material, by presenting the potentially alienating material in a context of, or through, something else. Pedagogically, these arrangements can sound, allowing students who would be anxious to be carefully guided through new content. Such arrangements can

allow student confidence and self-efficacy to be carefully nurtured, qualities which, as has already been discussed, are important for engagement. Approaching these topics directly could risk demotivating the more anxious students. However this can mean that sometimes students are surprised by aspects of their courses' content and some individuals may respond more positively if they are aware of what they face. Of course there is a balance of concerns here, but for some, this could be more alienating in the long-term than being absolutely explicit initially (Breen 2003) (Implication #5).

The range of routes available attracts a wide diversity of students with varying backgrounds and they enter HE with very different knowledge levels (§7.3.1). For example, some have excellent mathematics whilst many have no more than GCSE grade 'C'; many have never programmed before whilst others have been programming for many years. At one extreme many students from Eastern Europe have attended technical secondary schools where they developed excellent mathematics and a broad range of technical computing skills. This project showed that students who are asked to study material which is far removed from their needs can feel alienated and resentful, even when the work is trivial for them. They may absent themselves and become 'differently engaged', which as this work has shown is not necessarily problematic. However, as this research also indicated their absenteeism can spread and they could become dis-engaged. Conversely, those without a solid preparation may struggle and may not cope. Since there is a very wide gulf between these groups of students, to avoid some students becoming disaffected, this diversity needs addressing in course design (Implication #14).

Some more selective universities require applicants to have an A-level in Mathematics (§2.3) and sometimes it has been suggested that all computing degrees should seek this for entry. Imposing such a requirement would have the benefit of dramatically reducing the diversity of new entrants' backgrounds. However, even if it was deemed academically appropriate, not all universities could demand this. There are simply insufficient Mathematics A-level candidates. It could be argued that if all computing courses required this qualification more pupils would study it, and no doubt there would be some such

effect. However despite the significant resurgence in interest in Mathematics A-level in recent years, it would deter too many applicants. Additionally, for some computing degrees it is an appropriate requirement but for many it is not. Whilst computing does require some mathematical skills, depending on the precise content of the degree they are, mostly, somewhat different and largely less demanding than the A-level. Despite this relatively low-level mathematics content in many computing degrees, as this research confirmed, it can be problematic. Quite a number of students struggle: some cope, but others fail (Implication #6).

The benefit, or not, of students already possessing Computing A-level is also subject to debate (§2.3). It is probably true that if universities required it, more pupils would select it. However currently, not many schools offer it so such a policy would exclude many potential applicants. As the revised National Curriculum phases in, and schools change their teaching and options, so more pupils will have the opportunity to take it. However it may never be available to all pupils. A few universities are supporting its uptake, for instance by saying that they "*particularly welcome*" (University of Kent 2013) candidates with Computing GCSE or A-level. However Computing is not on the Russell Group's list of the most desired 'facilitating' subjects (Russell Group 2012), which means pupils with high aspirations will tend to avoid it. Also, students tend to get lower grades in Computing A-level than many other subjects. In 2012, only 61% of Computing and ICT A-level students achieved a grade 'C' or above, compared with 82% for Mathematics and 77% across all subjects (JCQ 2012). These factors would tend to deter top students (BCS 2010b) and this research did encounter pupils who were advised to take Mathematics in preference to Computing, even though they had been clear that CS was their degree preference.

A remarkably high proportion of participants in this research had taken A-level Computing (§6.4.1) and they were making their choices on a personal basis. As this work illustrates, it was their individual, often out-of-school, exposure to computing which had led them to their choice. However, combined with the limited availability of A-level Computing in schools, this reinforces my analysis

that very many pupils are simply excluded from making an informed choice to choose a computing degree and confirms the potential benefit of exposing all pupils to some technical computing.

The biggest dilemma relates to the benefit of the A-level itself, to university courses. Until new entrants can be expected to have it university courses will need to accommodate those students who do not. However in the past (say, 15 years ago), when many entrants did have A-level Computing, many tutors complained that they needed to help students to discontinue bad habits which they had acquired. Indeed some universities said they preferred students not to take this qualification and some students who wanted to take a CS degree have been advised against taking the A-level (Brown *et al.* 2013). At least one participant in the current research had been so advised. It has been said that Computing A-level: "*is not considered suitable support for any degree*" (Brown *et al.* 2013:2). The revised A-level syllabi require more rigour and skill from the student than the immediately preceding ones, reverting to material more like that in even earlier versions. Whilst this change is not likely to help the grade profile of the subject, it may help the academic reputation of pupils who take it. There remains however little reason to encourage a bright student, aiming for a highly selective university, to take this subject.

I have now completed my consideration of the three main areas of implications of this research, and for these issues in the immediate future: the profile of computing, forthcoming changes to computing in schools and some structural and recruitment issues relating to computing degrees. I will now present the implications that I see for various stakeholders and then move on to evaluate this project and present some final reflections.

9.5 Implications for Stakeholders

In order to progress the overall objective of recruiting more appropriate students into computing courses and preparing them for graduate life and IT employment, the findings of this project point to a number of implications and suggestions for

stakeholders. These are presented, grouped by stakeholder. For each, references are given to the location of my supporting arguments.

British Computer Society (and other professional bodies)

Perhaps working in conjunction with CAS and eSkillsUK:

1. Both this project and the literature indicate that there is a need to change the public image of computing and the IT profession. It may help if there were activities and publicity, aimed at the general public, describing some computing successes, which give some indication of the intellectual processes and the people behind them. This should raise the profile of the profession; give a sense of the wide range of tasks and activities involved and confront the image of the 'geek', by presenting IT professionals as personable, effective human beings. Cost-effective, broad distribution channels would be needed. It might be worth investigating the effectiveness of creating a series of light-hearted YouTube videos, released through social media, perhaps linked to some television exposure. It might be useful if some of this material were aimed at pre-teens, in order to influence them before negative stereotypes impact. It might be worth considering generating these, or at least ideas for these, through a Student Competition. (See §8.2, §8.3 and §9.2).
2. It may be worth investigating if there is a need for resources such as a magazine for school careers teachers and advisors, covering opportunities and job roles. Something with similar content for teachers could be disseminated, maybe via TESConnect. (See §8.2, §8.3 and §8.5). A magazine could be modelled on CS4FN (2013), aimed at young people, which presents applications of computing.

University Lecturers and Course Leaders

3. Most lecturers probably already try to make their teaching relevant and interesting. However, this research showed that students are not always clear why they are being asked to master some aspects of their course, typically mathematics. Understanding the relevance of material is important for student engagement. Hence, particularly for more challenging or theoretical topics, it is important that students understand the relevance of material: how they might use it on their course or later (see Chapter 7 and §9.2).
4. To support students in their learning, all courses should ensure they engender a learning community, one which is accepting of all students and generates a sense of belonging in students. The literature suggests that staff need to relate to students on a human level, although as mentors rather than friends. They should care about the progress and general circumstance of each student (see §8.4).
5. Some students are surprised by elements of course content. Whilst this research found that many students undertake very little investigation into the content of the courses for which they apply, course information should provide enough detail to applicants, maybe via a website, such that diligent applicants are not surprised by substantial aspects of course content. Although there is some commercial sensitivity associated, it may assist some applicants if more than a list of module titles were available. (See §8.3, §9.2 and §9.4).
6. Some new entrants struggle with the mathematics, even on courses which are not mathematics-focussed. Many students arrive with only a GCSE Grade 'C', or equivalent. It may be worth investigating if those are the students who really struggle and therefore if raising the entry requirement to Grade 'B' would be helpful. Alternatively it may be useful to consider developing something like a short, pre-sessional, online mathematics revision course for those candidates who have only a

Grade 'C', the passing of which could be a condition of admission (see §8.4 and §9.4).

7. Many participants expressed enthusiasm for the opportunity to exercise their imagination. Hence course designers could consider if they can exploit this enthusiasm by building flexibility into their assessments, whilst still bounding tasks with clear assessment criteria (see §8.4).
8. As this research made clear, many students, even those enrolled on computing courses, know very little about the computing employment market and job opportunities. Whilst students have opportunities to talk to employers during visits and so forth some students' lack of knowledge can be profound. Students should be aware of a wide range of types of IT employment opportunities so they can decide what might interest them and suit their skills. Approaches which could be considered include talks from recent graduates, which might help, especially if they talk about employment issues generally and not just their personal career routes (see §8.2).
9. There may be benefit to be gained by considering if greater attention could be paid during the recruitment process to ensure that applicants are aware of the nature of the course for which they are applying. Whilst their understanding may be evident from their personal statement, in many cases it will not be. It cannot be assumed that the person providing the reference is well-informed either. When the revised National Curriculum is fully embedded it might be safer to assume that applicants understand the nature of the subject, but that is some years away. To achieve this assurance it may be necessary to interview all applicants. This is labour intensive and it seems that most universities do not currently do this but it might lead to long-term dividends in the form of enrolling students who are more interested and successful, even if overall recruitment is diminished (see §8.3 and §9.2).
10. Courses need to be designed with employment in mind. Some CS courses may aim to teach theory to the depth needed for subsequent

research work but most courses take a more vocational view and aim for industrial relevance, whilst still covering the necessary underpinning theoretical material. This was raised as an issue at some institutions, although not at Coventry. There seems to be no reason why a CS course for high-achieving students should not be very theoretical provided those students also acquire the practical skills necessary for relevant target employment (see §4.4.4 and §9.2).

11. Course leaders may wish to consider how they encourage student engagement and the approaches they adopt when addressing apparent dis-engagement. The models of engagement presented earlier (§7.3.5), although tentative, may be useful in developing supportive approaches (see §8.4).

University management

12. To ensure that the students recruited all have a real interest in their course (whether their motivation is intrinsic or extrinsic), universities need to be confident in their judgements and reject any applicants who they believe have significantly misunderstood the nature and qualities of the subject. This is not easily done if the student is academically quite strong. Whilst the immediate incentives can sometimes be to accept all plausible applicants this can lead to long term costs and problems, some of which are hidden or unquantifiable. (See §8.3 and §9.2).
13. Some participants were very clear that they want, and for their employment prospects they believe that they need, skills in the most current technologies. Whilst raised as a problem in this research, although not at Coventry, universities need to ensure that computing students have access to reasonably up-to-date and industrially-relevant facilities on which to learn their craft. Computing students need access to some specialist facilities so a standard university PC and software image is likely to be too restrictive. Open source and free software can be used for some learning, as can old or less common packages. Nonetheless for most students it is important to know they have some

skills which will be of use to employers both so they feel that they have agency to apply for advertised vacancies and so they have the confidence to 'sell' themselves in interviews. (See §4.4.4 and §9.2).

14. To avoid the demotivating effect of being required to study inappropriate content, courses should allow students to build upon their existing skills. In particular students should not have to take modules which are a long way below their current capability. At Coventry University, and probably elsewhere, this maybe could be addressed through the use of the Accreditation of Prior Learning (APL) scheme, perhaps by ensuring students' creditworthiness using a start-of-module assessment, and accredited students being encouraged to take a replacement module. Alternatively, a scheme with explicit multiple entry points could be derived. Such arrangements would be disruptive to Coventry's move to course-focussed teaching and assessment and the latter may not be permitted by Coventry's regulations. However Coventry's move to project-based learning may mitigate the problem for some of the affected students, allowing them to operate 'as expert' in their teams. (See §8.4 and §9.4).

Governmental agencies: Department for Business, Innovation and Skills (BIS), Department for Education (DfE), Teaching Agency

15. This research, and the literature, indicates that there is a need to increase the visibility and potential appeal of computing. To this end, it would be helpful if consideration was given to extending STEM initiatives to embrace computing and IT, other than when there is an overwhelming reason not to do so. This would support computing in raising its profile and enhance its recruitment opportunities through the various STEM initiatives. Additionally, it may be helpful if computing was clearly identified in STEM activities. For clarity, when the acronym STEM is 'decoded', computing should be explicitly identified as being embraced, perhaps as part of 'technology'. For information aimed at the general public this is not an issue since they probably already presume STEM

includes computing. However schools and universities are very familiar with examples of STEM activities where computing is excluded (see §9.2).

16. Since there is a need for many more computing teachers in schools, the recent funding for scholarships and bursaries for training new computing teachers should remain in place long term (see §9.3). These will help attract graduates into teaching.
17. Introducing the revised Computing National Curriculum into schools will require large numbers of additional skilled or retrained computing teachers. It will be some years before they are available in adequate numbers (see §9.3). Hence it may be useful to consider delaying the statutory requirement to comply with the revised curriculum for a period of, say 2 years, to allow time for more teachers to be trained or retrained. This may allow the curriculum's smoother, more effective introduction. The Royal Society (2012) recommended both that the statutory requirement was delayed pending adequate staffing and the setting of targets for training the necessary teachers.

Schools/Local Education Authorities

18. School Heads and local education authorities need to consider how they will meet the requirements of the revised National Curriculum. However, since it substantially differs from the previous ICT curriculum, for the Computing curriculum they will need particularly to consider the availability of appropriate staff expertise. This applies to the secondary sector but also to primary where it may prove particularly challenging since almost all teachers work across the curriculum (see §9.3).

Careers staff

19. Some participants were clear that careers staff did not necessarily have an accurate view of the nature of computing. Careers staff, including relevant school teachers, need to be aware of the nature of IT employment and the skills required. In particular the range of job roles in

the industry needs to be clear. If suitable materials were available (Implications #1 and #2), it may help achieve this (see §8.3).

IT employers (via Intellect and eSkillsUK)

20. Some portion of the skills gap in IT must be attributable to the inflexibility of some employers' recruitment requirements. To assist with providing graduates with employment opportunities and to help with skills development and availability in the sector generally, employers need to be as flexible as possible in their advertising and recruitment of staff, particularly first-level graduate jobs (see §9.2).

9.6 Evaluation

Having looked at the wider implications of this project the next task is to evaluate it. I will address this by looking initially at the largest-scale matters, the methodology, and then considering aspects of the execution of this methodology and the various methods adopted. Finally I will comment on the project's rigour.

Methodology Issues

In designing this project it was very clear that a qualitative study of some sort was required. As has been said, previous research looking at these issues has mostly been quantitative and whilst some of these have revealed patterns and correlations between factors, they provide little illumination as to the underlying reasons, processes and influences. To endeavour to discern those, I needed to develop a qualitative project. The insight that there can be inappropriate course applications in addition to inappropriate recruitment by institutions, for example, is unlikely to have been revealed by a quantitative study. My purpose was not to identify any fixed 'rules' or deterministic systems of interaction: such rules are not to be expected from a social system where individuals have at least some measure of agency. Also, in saying that "X tends to happen" I am not excluding the possibility that for some students it is "Y". I have not tried to articulate the

position for every participant: I have been trying to identify patterns which may, but need not, be repeated between participants.

There are other qualitative methodologies which I could have adopted, most obviously perhaps Grounded Theory. However this was not adopted since, as an insider, it must be harder to objectively code the participants' narratives. In hindsight, it may have been an easier approach to use overall, since the analytical process is driven by the coding. The approach adopted, of using thematic analysis and a conceptual framework of a principal and two supporting analytical devices, was quite messy to manage. However it was productive and did let some interesting findings surface. Also, it permitted my insider knowledge to be used during the interpretation, where specific empirical data was lacking. I used such knowledge sparingly and carefully, where it was important and seemed secure, and acknowledging it.

The abductive research strategy adopted, which allows additional data to be generated, alongside analysis and theory-building work, was very helpful in allowing methods and instruments to evolve, in the light of experience and early findings. As new opportunities for data collection or fresh avenues for exploration were detected, these were incorporated into the project. In this way the engagement study was introduced when it became clear that existing participants were mostly reasonably well-engaged and the image study when the HEA STEM image competition was launched.

The three theories chosen for use as analytical devices in the conceptual framework proved effective. The benefits of each have already been discussed (Chapter 8). ANT, and more particularly the AAD diagramming technique developed for this project, was very helpful in providing a way to focus in on the key relationships and themes emerging from the data. Developing an AAD diagram forces the identification of the actors in a context. That ANT can operate with both animate and inanimate objects allowed the modelling of a wide range of situations. The diagramming process then requires the relationships between those actors to be recognised, both direct associations but also perhaps hierarchical nesting of lesser actors within a larger one. To complete the

diagram the analyst then must decide the optionality and durability of each of these elements, to decide if they should be represented as fire, fluid or immutable mobile. This drawing activity forces close attention to be paid to the detail of the evidence, revealing the processes, social and otherwise, at play in that context. This proved to be a very useful analytical tool which could be adopted widely.

Using the Structure-Agency and Social Practice theories complemented this, deepening and providing additional insights. However these two theories both tended to reveal issues relating to social structures and the associated human agency. Thus, in the coding tables presented in Chapters 5-7, these theories often occur together. This was unexpected although not problematic. Indeed maybe this should have been expected: these are both theories dealing with the position of the individual within society.

As has been said (§4.3.1), many other theories could have been adopted instead of these ones, with appropriate attention given to their underlying assumptions. It is acknowledged that a different makeup of conceptual framework would have led to different issues emerging from this project. Indeed I could re-analyse my data corpus using different guiding concepts and generate different results: results which are equally valid but which may be more or less interesting and relevant to the project's domain.

Study Design and Participant Recruitment

Running a preliminary study at the very commencement of the project was very beneficial. Views of academics from across the university sector were secured. This provided confidence and reassurance that the project was worthwhile, provided some leads for investigation, whilst also leading me to believe that my findings would have a widespread relevance and some degree of transferability.

Initially, the ideal study group was seen as longitudinal participants (ages 17-18), who were engaged with the project as they made their course choices, through to and beyond their enrolment. It was understanding the development of their thinking that was being sought. If recruitment to this study had been more

successful I would not have set up the focus groups or in-module study. However these were set up because more data and richness was sought. These studies were both seen as sub-optimal because these students were being asked about their previous attitudes and decisions which are vulnerable both to faulty memory and to *post hoc* justification (conscious or otherwise). However the focus groups in particular were very beneficial. As the literature suggests (§4.5.3), they led to the generation of many useful ideas. Nevertheless, whilst the focus groups were very helpful in broadening the narratives, it was harder sometimes to ascertain the background to and context of students' comments. Thus their influences and social processes could be difficult to discern. This did prove to be a limitation, restricting the meaning which could be drawn from those contributions. By contrast, the extended engagement with the longitudinal participants made it easier to understand their positions. Thus, whilst not initially planned, this combination of studies complemented each other quite well.

This project suggests that some pupils have developed a strong interest in computing by quite a young age. Similarly some of the literature (§2.6.1) suggests that some pupils have dismissed it as an option by, say, ages 12-14. Whilst it might have been useful if this project had been based on such a young cohort, it was important to track participants to their ultimate course choices, and time was not available for a more extended study.

I conducted this research at Coventry University, working mostly with students enrolled or applying there. However in order to capture data from a broader range of students, for the longitudinal study I was able to recruit participants through another, rather different, institution too. This did increase the diversity of participants although, due to limited recruitment, only a little. This project would have been enhanced if participants had been recruited more broadly since they might have brought a wider range of experiences, views and attitudes. Whilst this can be considered to be a limitation it does not invalidate the findings which were obtained.

Participants for most studies were self-selected volunteers. This could mean that they were not representative of all students or that they volunteered to

promote some personal agenda. The latter presents the risk that the views and experiences described by participants are not entirely honest. Vigilance, delving deep in discussions and cross-checking are needed to try to ensure that honest participant opinions are recorded. However these actions are needed routinely with all participants, in order to gain a fair and accurate understanding. The lack of representativeness of participants could be problematic with some methodologies. However here I was not trying to present any form of quantification of findings: I was identifying patterns and influences. However students are all individuals, each with their own personal set of influences and responses. The findings which I presented are those which were prevalent or of particular interest.

Largely, I was producing substantive theories. These are theories applicable to the context of this project: "*theories about the particular*" (Trowler 2012b:276). I endeavoured to develop propositions, based on my data, which provide an enhanced understanding of my research context (*ibid.*). The generalisability of these findings to other contexts would need to be tested. However, I have already discussed (§8.5) the extent to which I would anticipate them to be transferable. I have attempted to relate my findings to pre-existing theories, as a form of "*theoretical integration*" (Urquhart 2013:185), placing them into the wider context of existing knowledge.

Using Walsham's categorisation of research contributions (Urquhart 2013), I have made all four types in this project. Much that I produced was as "*a contribution to rich insight*" (*ibid.*:171), generating an improved, deepened understanding of the research context. Some contributions, for example those related to engagement, form "*contributions to theory*" (*ibid.*:171). New concepts have been developed, such as ANT analysis diagrams (AADs) and that some students are 'differently engaged'. Finally, I have also presented a series of "*specific implications*" (*ibid.*:171) for action for stakeholders.

My attempts to access disengaged students were not very successful, even with targeted approaches. Of course this will be a common problem. If they are poorly engaged with their course then there is little reason why they might feel

inclined to get involved with something as peripheral to their concerns as a research project. Such students just might have been more willing to help if I had had some form of relationship with them from early in their course but they would no doubt remain hard to reach. Whilst I was able to make some useful observations about the way disengagement is perceived and constructed from those who were recruited, they gave me very little understanding about the truly disengaged where other issues may come into play. This is an unfortunate limitation of this work.

Methods

This project was about gaining an understanding of the relevant social processes affecting youngsters. To secure this it was necessary to use lightly structured and interactive methods, allowing issues to be explored with participants to develop understandings. However that is not to say there was no structure. All interviews and discussions were guided by a loose schedule, but elaborations were sought as necessary, digging for deeper understandings. During planning, this requirement made it clear that the project's key methods would be interviews and group discussions. Indeed it did prove that these methods secured much of the richest data. Reflections on the conduct of these key methods have already been presented (§4.5.2, §4.5.3).

A range of other methods was used too, in an effort to increase understanding of the participants – to enhance their profiles – to varying degrees of benefit. The methods which were used in each study were discussed in Chapter 4. In the longitudinal study the use of some additional methods was necessary to provide a means of keeping participants in touch with the project over an extended period of up to 18 months. Some of these methods (such as the tagcloud and Wordle) were designed in the hope participants might find them enjoyable and interesting, as well as providing valuable data, and that did seem to be the case. For some methods participant engagement proved to be their only use, although that was never the intention. Some of these additional methods were useful during the analysis and their data formed part of the evidence presented in this

thesis. The data from some other methods were not fully considered in this project but they may have potential use for future work.

As has already been discussed (§4.3.1), there can be concerns about conflicts in the underlying epistemological assumptions when a range of methods are employed. No such tension was detected here, in the way the methods were actually employed. However had, say, the personality testing instruments been used to derive understandings about the study group as a whole, then it may well have been difficult to reconcile those findings with the accounts from individual participants, the former being based on a positivist premise of an absolute measurement of group characteristics and the latter based on a co-constructed interpretations.

Data Collection

My main purpose for this research was to bring about change. Indeed I presented the project to participants as endeavouring to ensure that the most appropriate students enrolled on computing courses by better understanding the motivation for application – hence the '*Why Computing?*' title. In hindsight it might have been more effective in 'getting under the skin' of participants to promote my identity as a student rather more. This would have distanced me more from immediate operational matters. However I suspect recruitment would have been really problematic had I done that. This is not to imply that students were not open with me: they were very happy to talk and exhibited no signs of being reticent. Whilst all such research data is a co-construction – an artefact of work between researcher and participant – I do however wonder how far some contributions should be trusted. Whilst interview dialogue, there were a few occasions where I wondered whether some students were reacting to my lecturer identity and were dissembling during our conversation. I wondered if the double hermeneutic (Giddens 1993) was in action, with a participant trying to show that they were aware of the social dynamic of some of the issues at play this research. A few comments seemed unnatural, lacking in nuance and almost scripted, as though reflecting back ideas heard previously, perhaps articulated by staff. Efforts were made to explore further, re-visit, cross-check and back-track

but ultimately it seemed unsafe to rely upon one or two statements and, whilst not relating to anything particularly significant, these were disregarded.

As I described in the introduction, during this work I recognised the tensions of being something of an insider. These compound the difficulties of endeavouring to work with an open mind but it is neither possible nor desirable to aim to have an empty head (§4.4.10). Being an insider brought real advantage. It eased access to participants but, more importantly, I recognised the significance of what they were saying. When Martin spoke about working with Microsoft Disk Operating System (MS-DOS) I realised that whilst such activity is unusual these days, it can be intellectually trivial. However when he spoke about interconnecting the operation of programs I realised that this was much more significant. When John spoke about his peers' difficulties with their Etch-a-Sketch algorithms I was aware that he was talking about their difficulties with basic trigonometry. Outsiders are unlikely to discern such matters.

I wish I had pursued some lines of discussion further, probing more and accepting less. I had a tendency to stop probing when the participant was talking about predicted and predictable issues: when they were on familiar territory. But, of course, pursuing such topics further might have led to improved, deepened understandings. Also, it would have been useful if I had encountered the Schulte and Knobelsdorf (2007) paper at a much earlier stage. The distinction they identified of three types of computing activity (use, design and 'professional use') might have been useful in further clarifying participants' meanings during discussions.

Data Analysis and Interpretation

Most of the main issues relating to the analysis and interpretation processes have already been discussed in this or previous chapters. However it is worth reiterating that the findings of this project are the product of the particular theories used to guide it and the emerging categories and themes which I felt were significant-enough to merit pursuing through the data corpus. A researcher with a different background would undoubtedly have homed in on different

aspects. This is not to invalidate the current project merely to recognise that it is not, and could not ever be, the one 'correct' result. It is the product of its origins.

Rigour

Considering the rigour and quality of this project, I addressed the general principles of credibility, authenticity and trustworthiness (§4.3.3). I believe I have created an authentic, valid and clear account, drawing in information surrounding the computing academic community, as well as materials gathered directly from participants. I have endeavoured to create a trustworthy account by being diligent, cross-checking and back-tracking, revisiting transcripts and recordings as necessary, trying to ensure that each participant is represented as accurately as possible: have I really understood them?

I believe my account to be credible too. A different researcher would no doubt consider my data and produce an account with a different emphasis. I have tried to look at my data as an outsider, although it is impossible to say if I have completely avoided insider bias (§1.3.3). However I believe that a fellow Computer Science academic, especially one from a post-1992 university who would have a similar interpretive scheme, would identify a very similar set of issues. A computing academic from a more selective university or from a small, very new (post-2000) university, would probably extract overlapping although perhaps different sets of issues as being of prime concern and someone from outside the discipline would focus on issues which were yet more different.

9.7 Reflections

And finally, some personal observations.

Perhaps as a consequence of working almost my entire career in the context in which this project is set, I have quite an attachment to the issues in this thesis and the people involved, both those who participated in this project and those in the wider communities affected. Maybe I should welcome the changes in the school curriculum. However the imbalance, speed of change and lack of clarity

about objectives leads me to wonder if the future may not be even more problematic than the present, for schools, universities and employers of computing graduates. These changes may prove to be an opportunity lost.

Lastly, as someone trained in the traditions of science, this was my first significant foray into interpretive work. It has been fascinating but challenging. However it has let me achieve what I set out to do and generate a better understanding of the social dynamics at play as regards opting to study computing.

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APPENDICES

A – Participant Profiles

Pseudonym	Research study(s)	Gender	Course or group ⁴⁰ (enrolled on or of interest)	course stage (or year of entry)	International/immigrants Computing background Mature (over 21 at enrolment)
Alex	Longitudinal	male	decided against computing chose mathematics	2012	A-level ICT
Arthur	Engagement	male	Computing	1	recent immigrant from Far East
Avtar	Focus Group 3	male	Computer Science	1	immigrant from Africa aged c16, mature, BTEC National IT
Carl	Focus Group 2	male	Computer Science	1	mature
Charlie	Longitudinal	male	Computer Science or Ethical Hacking	2013	A-level ICT ; entry 2013
Chris	Focus Group 4	male	Computer Science	1	A-level ICT
Dave	Longitudinal	male	Software Engineering	2012	A-level Computing
Dee	Engagement	male	creative	1	Eastern Europe; A-level Computing (equivalent)
Emma	Longitudinal	female	Forensic computing	2012	GCSE-level DIDA; chose not to go to university
Ez	Engagement	male	Computing	1	A-level ICT
Farouk	Focus Group 2	male	Software Engineering	1	immigrant from Middle-East aged c16, HNC Computing

⁴⁰ Creative courses: Games Technology, Multimedia Computing, or Creative Computing

Appendix A

Fidel Angel	Engagement	male	Ethical Hacking	2	Middle-East; mature
Imogen	Image	female	IT and Computing	1	
Innocent	Focus Group 4	male	Computing	1	GCSE IT
James Anderson	Engagement	male	Computer Science	1	Eastern Europe
Jason	Longitudinal	male	Ethical Hacking or engineering	2012	A-level Computing; Chose not to go to university Chose engineering over computing
Jay	In module	male	Computer Science	1	A-level ICT
Jessica	Longitudinal	female	creative	2012	A-level ICT
Joey	Longitudinal	male	Computer Science	2012	GCSE ICT
John	Focus Group 1	male	creative	1	BTEC Software Development (level 3)
Justin	Focus Group 4	male	creative	1	AS Computing; BTEC National IT practitioner
Les	Image	male	Computer Science	2	
Martin	Focus Group 4 and In Module	male	Computer Science	1	disability; BTEC ICT
Matthew	Focus Group 1	male	Computing	1	A-level IT (equivalent), mature, Eastern Europe
Michael	Focus Group 3 and In Module	male	creative	1	mature, employed in IT. Access entrant
Myndtrick	In module	male	creative	1	Eastern Europe; extra-curricula courses in school
Neil	Longitudinal	male	Computer Forensics	2012	A-level ICT
Nhoj Xela	Engagement	male	Software Engineering	2	Eastern Europe; mature

Nick	Engagement	male	Computer Science	1	Eastern Europe
Nicole	In module	female	creative	1	GCSE ICT
Omar	Focus Group 3	male	creative	1	BTEC National IT practitioner
Pete	Engagement	male	Computer Science	3	mature
Raith	Image	male	Computer Information Technology	unknown	
Rebel	Longitudinal	female	Computer Hardware and SE	2013	A-level ICT; entry 2013; interested in making products
Richard	Engagement	male	Computer Science	1	Middle-East
Rustyrose	Longitudinal	male	Computer Forensics	2012	A-level Computing
Scarab	Longitudinal	male	Computer Science	2012	A-level Computing
Sunny	Longitudinal	male	computing or engineering	2013	A-level ICT ; entry 2013
Tad	In module	male	Ethical Hacking	1	Very little input; mature; African
Teken	Longitudinal	male	creative	2012	OCR National ICT
Trevor	Image	male?	New Media module	2	
Victoria	Focus Group 3 and In Module	female	Computer Science	1	A-level ICT

Table A-1: Participant profiles

Appendix A

<i>Participant</i>	<i>Institution type</i>	<i>Institution's campaign group⁴¹</i>
A1	post 2000 university	unaffiliated
A2	post 1992 university	university alliance
A3	post 1992 university	million+
A4	pre 1992 university	unaffiliated
A5	post 1992 university	million+
A6	pre 1992 university	Russell group
A7	pre 1992 university	1994 group
A8	pre 1992 university	Russell group
A9	pre 1992 university	Russell group
A10	pre 1992 university	1994 group
A11	post 1992 university	million+
A21	post 1992 university	million+
A22	post 1992 university	million+
A23	post 1992 university	million+
A24	post 1992 university	million+
A25	post 1992 university	million+
A26	post 1992 university	million+
A27	post 1992 university	million+
A28	post 1992 university	million+

Table A-2: Preliminary study participant profiles

⁴¹ The Complete University Guide 2011 (URL:<http://www.thecompleteuniversityguide.co.uk>)

B – Methods and Studies

Method	Description	Research studies						used in data analysis and described in §4.5
		preliminary	longitudinal	focus groups	in-module	engagement	image participants	
Interview	See §4.5	✓	✓	✓	✓	✓		Y
Group meeting	See §4.5			✓	✓			Y
Personality testing instruments								
Academic Motivation Scale (AMS) *	A validated psychometric tool which assesses each of intrinsic and extrinsic motivation (range 12-84) and amotivation (range 4-28) (Vallerand <i>et al.</i> 1992). See also §3.6.1.		✓		✓			N
Motivated Strategies for Learning Questionnaire (MSLQ) **	A validated psychometric tool which assesses 15 measures including intrinsic and extrinsic goal orientation, task value, self-efficacy, test anxiety and meta-cognitive self-regulation (range 1-7) Pintrich <i>et al.</i> (1991, 1993). See also §3.6.1.				✓			N
Mental Muscle Diagram Indicator (MMDI) TM ***	A freely-available validated psychometric tool which creates a score on the 4 dimensions of introvert-extrovert; sensing-intuitive;				✓			N

Appendix B

	thinking-feeling; judging-perceiving. A version of the Myers-Briggs assessment (Team Technology 2013, Computer Weekly 2008).							
Personality traits (BBC/Open University) ⁺	A freely-available validated psychometric tool which assesses 5 personality traits: openness, conscientiousness, extroversion, agreeableness, neuroticism (for example, Komarraju, Karau and Schmeck 2008, BBC 2013).				✓			N
Image of computing instruments								
Image competition ⁺⁺	HEA STEM Image Competition entries.						✓	Y
Image tagcloud ⁺⁺⁺	An interactive website developed to allow students to create a tagcloud, rating issues to reflect their view of the image of computing. Issues were based on Mitchell (2005).		✓		✓			Y
Wordle™ [#]	Wordle was used to create a graphic of terms which are the key features of what they see as the image of computing as a career area.				✓			Y
Image collection	A set of diverse images relating to computing was assembled and used to trigger discussions in the focus groups.			✓				Y
'Images of Computing' scrapbook ^{##}	Students created a digital scrapbook of representative images of computing. Scrapbooks based on Bragg and Buckingham (2008).		✓		✓			Y
Attitudes to computing questionnaire ^{###}	Data collection tool of rankings of students' reasons for choosing computing; views of university computing; study styles; self confidence with using computers. Questions derived from Solomon, Lawson and Croft (2011) with supplementary questions based on Durndell, Haag and Laithwaite (2000) and Ruslanov and Yolevich (2010).				✓			N
Career and choice instruments								
How did you decide: Pyramid of career influences ^{*#}	A practical exercise in ranking of people who helped with course choices and the resources and events used in that process,		✓		✓			Y

Appendix B

	ranked as a diamond (Woolner <i>et al.</i> 2009), with reasons for rankings provided.							
How did you decide: Timeline ^{**#}	Creation of a timeline graph of the development of commitment to the chosen course subject, since early childhood.		✓		✓			N
Factors affecting career choice questionnaire ^{**#}	Data collection tool of ratings of the importance of issues related to the sources of careers advice; career knowledge; self-efficacy; desired career features. Taken from Alexander <i>et al.</i> (2011). Adopted because of its use in Social Cognitive Career Theory, which was explored for use.		✓		✓			N
Reasons for non-engagement ranking cards	Diamond ranking exercise from Woolner <i>et al.</i> (2009) of reasons for non-engagement. Reasons based on Broughan (2009), Yorke and Longden (2008) and NAO (2007).							N
In-module portfolio assessment	Reflective personal development portfolio pre-existing module assessment.				✓			N
Day in the Life	An account of a typical day as a computing student				✓			N

Appendix B

*	Was available via: http://www.survey.bris.ac.uk/coventry/ams_post
**	Was available via: http://www.survey.bris.ac.uk/coventry/post_mslq
***	Available at: http://www.teamtechnology.co.uk/mmdi/questionnaire/
+	Available at: https://www.bbc.co.uk/labuk/experiments/personality/
++	Available at: http://babbage.coventry.ac.uk/csx067/why/image.asp
+++	Exercise available at: http://babbage.coventry.ac.uk/csx067/why/displayCloud.asp
#	http://www.wordle.net/
##	Available at: http://babbage.coventry.ac.uk/csx067/why/documents/Images of Computing v2.doc
###	Available at: http://babbage.coventry.ac.uk/csx067/why/documents/Attitude to Computing v1.doc
*#	Available at: http://babbage.coventry.ac.uk/csx067/why/documents/How did you decide module v1.doc
**#	Was available via: http://www.survey.bris.ac.uk/coventry/career-choice

Table B-1: Methods and studies

C – 'Day in the Life of a Computing Student'

08:00am to 09:00am

On a normal day I will wake up at 8am and get ready to be in University for 9am, which will include leaving my accommodation around quarter to the hour in order to be on time.

09:00am – 10:00am

The first lecture of the day starts in one of the brand new lecture theatres in the Engineering and Computing building. A PowerPoint slideshow is shown on the screen explaining the aims of what we are going to learn in the lecture today and the content to go with it. As we go through the presentation the students are asked questions in order to interact in the lecture. At the end of the lecture the laboratory tasks are put up at the end with a brief explanation from the lecturer on what we have to do.

10:00am – 11:00am

There is then normally a one hour break before the start of the laboratories sessions, which may or may not be related to the module we just had the lecture in. In this period I will either head to the library and complete some work, or I may return back to my accommodation for a snack.

11:00am – 13:00pm

In this period a two hour laboratory session starts, where we are required to complete this week's work for the portfolio. This then has to be given in at the end of the year. The lecturer will normally be there explaining what we have to do in more detail with teaching assistants also being there as well. Once the work has been explained, I will then try to complete the

Appendix C

work in the two hour slot. However sometimes it is not possible and hours outside the lab are required.

13:00pm – 14:00pm

Once the laboratories have been completed I will then go back to my accommodation for lunch and have a break from University work.

14:00pm – 16:00pm

This is the period, I normally go to the library to complete some of the lab sessions that I may not have finished during the session. Often I will have group work assignments to complete as well, so me and my team mates will use this time to meet up and see the work that has been completed and assign new work too.

16:00pm – 18:00pm

Often this is when we have tutorials in laboratories and we will be both learning about the content of a module as well as actually being set tasks in the session in order to practice. The assessment for these types of modules is usually an exam completed on the computers at the end of each term.

18:00pm – 20:00pm

Once the tutorial has been completed I will then go back to my accommodation to make some dinner and have a break from University.

20:00pm – 23:00pm

During this period, I will head back to the library to go over lecture slides especially parts where I may have not understood in the lecture. Often I will also revise if I have an exams coming up or complete any assignments or lab works due in soon as well.

by Jay

D – Interview and Focus Group Schedules

Selected schedules:

Preliminary Study schedule

Focus Group study schedule

Longitudinal study

#1 Participant life history

#2 Image of Computing scrapbook

#4 Immediately pre-enrolment

Engagement study schedule

Appendix D

Preliminary Study Interviews

Interview (semi structured) Schedule

Investigation of the perspectives of HE computing students - Preliminary Study

If necessary, some interviews may be conducted remotely, by email

Questions will be something like the following....

- Thanks for agreeing to participate. Take c 1 hour
 - Explain context - PhD start-up
 - Relates to Computing students in HE - computing, computer science courses. [Specialist courses largely excluded]
1. How would you characterise the profession of 'computer scientists'?
... the subject of computer science?
 2. How do you think students perceive 'computer scientists'? How would they characterise the profession?
... the subject of computer science?
How do they form these views?
 3. How motivated do you find computing students?
In your experience do you believe there is any problem with some students' motivation?
In what respects?
How does this manifest itself?
How frequent is this?
What do you think influences this?

What differences in motivation have you noticed across computing courses?
How would you explain this?
 4. In what ways do you think computing students' courses fit their expectations? or not?
How does this become evident?
How frequent is this?
Does this matter?
Why do you believe this occurs?

Does this apply to students on all computing courses?
 5. In what ways do you think expectations mismatches are linked to misunderstandings about computing?
How far is course design at fault?
In your opinion, what is missing from courses or the way we design courses?
 6. In your opinion, what factors do you think lead to these mismatches in motivation and expectation?
 7. If you could somehow magically ensure every new student was aware of some feature of their course what would it be? ('Feature' (ie attribute/idiosyncrasy) not academic subject knowledge)
 8. What issues/aspects of computing students' perspectives do you feel would merit investigation?

Lisa Payne, Aug 2010 v2

Appendix D

Focus Group Schedule

Focus groups – session 1 – Oct 2011

Practical:

Video as well as record – to see who talking – take video tripod; some still photos
Provide name labels incl course
Camera, video, recorder, tripod, video player charger, extension cable
Drinks (cola, water, fruit juice, cups) and biccys and fruit
Factual details at start – A levels (topics and grades) or from Universe, Open Day attendance Cov and elsewhere – on consent form
Flyers for in-module work

Briefing:

Permission forms & name labels
Comment on each others point of view – respect differences but say if you disagree
'Chatham House' rules
Natural conversation
Everyone have their say but not necessarily on everything
Duration 60-90 mins

Questions to explore, as many as time and energy permit in this order, generally:

'think of an example of computing or IT that influenced your choice of degree subject'
'what led you to choose computing?'
Brainstorm – words which portray image of computing
take in some images of professional computing activity and ask 'what they see'
'were any of your friends 'put off' studying computing, if so, by what?'

If time permits...

'what do you think a computing course will involve?'
'did you look at the modules you would be doing?'
'anything you want to add?'

Tidy up:

'Member checking'
May run a follow-up meeting after Christmas
Could get involved with more research work within 100cde – take flyers

V3

Longitudinal study: #1 Participant life history

Appendix D

Longitudinal Study: #1 – Interview: Participant life history

Prelude:

1. Turn recorders on
2. Approximate length of interview
3. Purpose of the interview: Clarification of the topic under discussion “about getting to know you and your background”
4. Format of the interview - some specific questions but some more open areas for discussion
5. Assure participant that s/he can decline to answer a question
6. Inform participant that they can ask questions during the interview
7. Assurance of confidentiality & anonymity
8. Confirm consent
9. Purpose of digital recorder – confirm it is being used.
10. For Skype, check audio and video are clear both ends
11. Ask questions in all the areas (in any order) unless material already volunteered

Questions:

1. Review data provided on Participant Details form - any queries
2. Siblings – ages, gender and education [occupation]
3. This interview is mainly about getting to know you and your background. To do that let's divide your life into 4 phases: early pre-school years; primary school (up to age c11); early secondary years (up to age c14) and then recent years.

[For each period] Considering the period can you describe your life: what was your life like?

[Prompts]

who was important to you?
were there any highly significant people at this time, maybe a teacher?
who looked after you after school/during holidays?
what did you enjoy doing? how did you spend your time? what were you good/bad at?
what did you do when you were with your friends? (*trial this*)
was there anything you really disliked in that period?
what was the community like where you lived?
ensure cover 3 worlds of home; school & peers
who provided support: with homework? advice re school? re future? specific examples

thinking about computing/ICT, did it feature in your life at this time: if so, how?
ensure include school and type

4. *If not covered:* were you brought up by your parents?
tell me about your parents/step-parents
their employment
education
- Will type up interview transcript and ask them to check it
 - Thank participant

Longitudinal study: #2 Image of Computing scrapbook

Appendix D

Longitudinal Study: #2 – Image of computing Interview based on scrapbook

Prelude:

1. Turn recorders on
2. For Skype, check audio and video are clear both ends
3. Approximate length of interview – 30 mins
4. Purpose of the interview: Clarification of the topic under discussion “image of computing”
5. Format of the interview – some specific questions but some more open areas for discussion
6. Assurance of confidentiality & anonymity
7. Ask questions in all the areas (in any order) unless material already volunteered

Questions:

1. How did you decide what items to include? Did you have to make any choices?
 2. What do these examples tell you about computing and its image?
 3. *Specific questions*
 4. Are any of these applications/uses ones you'd like to be involved with, for a career?
 - What sort of role would you like?
 5. What sort of people work in computing?
 - *If necessary:* Is there a stereotype of their personality or characteristics?
 -
 6. *If not yet mentioned:* What do you understand by the word 'geek'?
 - Are people who work in computing 'geeks'?
 7. *If not yet mentioned:* What about the term 'nerd'?
 8. You previously said that you were thinking of applying for a degree in X. Is that still your thinking?
 - Of all the computing courses available, why are you considering X?
 - What appeals to you about that course?
 - What do you think you will study?
 - Do you have any career plans?
-
- Will type up interview transcript and ask them to check it
 - Thank participant

2- Interview - Image of computing v1.doc

Longitudinal study: #4 Immediately pre-enrolment

Appendix D

Longitudinal Study: #4 – Interview: Immediately pre-enrolment Sept 2012

Prelude:

Confirm consent

Confirm re recording

Questions:

1. Enquire about status – which Uni to study what?
2. What issues/choices did you have?
 - A-level grades achieved (if not yet mentioned)
3. How do you view the prospect?
 - Uni generally?
 - Specific University now entering?
 - Course chosen?
4. Pseudonym of choice for reporting

Thanks

Will contact one final time in December

4 - pre-enrolment interview.doc

Engagement study schedule

Engagement Study – Interview #1

Require: reason cards; participant ID card; camera; light; FutureMe reminders

Prelude:

1. Agree and sign consent
2. Turn recorders on
3. Approximate length of interview – 30 mins
4. Purpose of the interview: to explore issues relating to student engagement
5. Format of the interview – some specific questions but some more open areas for discussion
6. Assurance of confidentiality & anonymity

Questions:

1. You are registered on course X. What led you here? Why did you choose this? First choice course/Uni?
 - What were you expecting to get out of your course?
2. There seems to be a concern related to your [*attendance / coursework submission / whatever*]. Why has this happened?
 - Identify all contributing reasons and factors
 - What support have you used?
3. Introduce standard items on cards
 - Arrange these in levels according to the degree their importance
 - Use 5 levels of significance – may end up 'diamond' shaped
 - Discard any cards which are totally irrelevant for you
 - Create new cards for any additional items

PHOTOGRAPH arrangement, along with participant ID (*use lighting*)

- Discuss arrangement – why things have been placed as they are?
- For top issues, can you see a way to resolve this - stop it being so problematic?
- Raise any apparent anomalies
- Having discussed this and thought a bit more, are you still happy with your arrangement? or do you want to move any?

If rearranged, re-PHOTOGRAPH arrangement

4. Review the evidence provided eg non-submission or non-attendance
 - If appropriate, what would you like to happen, going forwards?
 5. If relevant [*usually would be*], I'd like you to come back and talk again in a month or so. Is that okay?
 6. I'd also like you to sit down today and write yourself an email which will automatically be sent to you in 30 days, using the FutureMe website (FutureMe reminder note)
- Will type up interview transcript and ask them to check it
 - Thank participant

Diamond ranking from Woolner (2009)

Interview #1 v3.docx

E – Ethics Approval Forms

Main project:

- Approval Forms
- General usage: Participant Information Sheet and Consent Form
- In-module participants: Participant Information Sheet and Consent Form

Preliminary Study:

- Approval Forms
- Participant Information Sheet and Consent Form

Appendix E

Approval Form #1 (for main project)

**REGISTRY RESEARCH UNIT
ETHICS REVIEW FEEDBACK FORM**

(Review feedback should be completed within 10 working days)

Name of applicant: **Ann Louise 'Lisa' Payne** Faculty/School/Department: **Engineering and Computing**

Research project title: **To investigate the motivation of students who choose to study computing courses in Higher Education: Why Computing?**

Comments by the reviewer

1. Evaluation of the ethics of the proposal: All aspects covered
2. Evaluation of the participant information sheet and consent form: Ok
3. Recommendation: (Please indicate as appropriate and advise on any conditions. If there any conditions, the applicant will be required to resubmit his/her application and this will be sent to the same reviewer). <div style="margin-bottom: 10px;"><input checked="" type="checkbox"/> Approved - no conditions attached</div> <div style="margin-bottom: 10px;"><input type="checkbox"/> Approved with minor conditions (no need to resubmit)</div> <div style="margin-bottom: 10px;"><input type="checkbox"/> Conditional upon the following – please use additional sheets if necessary (please re-submit application)</div> <div style="margin-bottom: 10px;"><input type="checkbox"/> Rejected for the following reason(s) – please use other side if necessary</div> <div style="margin-bottom: 10px;"><input type="checkbox"/> Further advice/notes - please use other side if necessary</div>

Name of reviewer: **Prof P White**.....

Signature:

Date: **29/3/11**.....

Approval Form #2 (for main project)

REGISTRY RESEARCH UNIT
ETHICS REVIEW FEEDBACK FORM

(Review feedback should be completed within 10 working days)

Name of applicant: **Ann Louise 'Lisa' Payne** Faculty/School/Department: **Engineering and Computing**

Research project title: **To investigate the motivation of students who choose to study computing courses in Higher Education: Why Computing?**

Comments by the reviewer

1. Evaluation of the ethics of the proposal:

This is fine.

2. Evaluation of the participant information sheet and consent form:

This is fine.

3. Recommendation:

(Please indicate as appropriate and advise on any conditions. If there are any conditions, the applicant will be required to resubmit his/her application and this will be sent to the same reviewer).

☒

Approved - no conditions attached

☐

Approved with minor conditions (no need to resubmit)

☐

Conditional upon the following – please use additional sheets if necessary (please re-submit application)

☐

Rejected for the following reason(s) – please use other side if necessary

☐

Further advice/notes - please use other side if necessary

Name of reviewer: **Anne James**

Signature:

A James

Date: **26/3/2011**

Participant Information Sheet (for general usage)

General

Participant Information Sheet

Why Computing?: An investigation of the perspectives of HE computing students

1. Information about the project/Purpose of the project
This study is to investigate perceptions and expectations of computing, as a course and career
2. Why have I been chosen?
This study will involve students who are either in Higher Education or are thinking of applying for an HE course, and people involved or who influence this: parents, teachers, career staff, University academic staff. The study will involve students who apply to computing courses but students who decide NOT to apply are also of interest.
3. Do I have to take part?
No, participation is entirely voluntary. Your input would be very welcome though.
4. What do I have to do?
Course applicants & students: For the duration of the study you will be asked, at roughly monthly intervals, to respond to some questions or complete a quiz or questionnaire or something similar. This will continue until you enter the second year of your HE course (or you enrol on a non-computing HE course or you ask to withdraw from the study or the study terminates, probably in January 2013).
Most contact will be online. Facebook and a project website will be used. Some contact may be using a service such as Skype, an online 'video conference' facility. Some phone contact may be sought. Some personal contact may be sought with applicants or students who are local.
Some applicants & students may be recruited for a single interview or questionnaire or similar.
Other participants: Participation would involve interview and/or questionnaire completion.
5. What are the risks associated with this project?
None.
Course applicants & students: There is absolutely no way in which any information collected in this study could affect your application to study any course at Coventry University or elsewhere. Similarly, marks awarded during your studies would not be affected in any way by your involvement. (The exception would be if you also joined the separate within-module research work. That would be subject to a separate agreement.)
6. What are the benefits of taking part?
Nothing directly, to you as a participant. However it is hoped that participants might find at least elements of the investigation to be interesting and valuable.
7. Withdrawal options
You may, of course, withdraw at any time though this would be disappointing since all contributions are valuable. In such circumstances, if you wish, all information collected about you could be destroyed.
8. Data protection & confidentiality
Data will be held in password-protected files (as far as possible). Files will usually be stored in the researcher's home. Data will be stored anonymously, against a 'participant code', from the earliest possible stage.
Any publications or other outputs will be written without identifying any participants. In addition, efforts will be made to ensure participants' contributions cannot be identified 'by deduction'.
9. What if things go wrong? Who to complain to
Director of Studies: Dr Lynn Clouder or Head of Department: Mr Chris Bland
10. What will happen with the results of the study?
This study will form the basis of a PhD dissertation. Key findings will also be submitted for publication or for presentation at conferences.
11. Who has reviewed this study?
Director of Studies: Dr Lynn Clouder and Faculty of Engineering & Computing Ethics Panel.
12. Further information/Key contact details
If you have any queries about this research, please contact Lisa Payne, Department of Computing and the Digital Environment, Coventry University. email: csx067@coventry.ac.uk

Lisa Payne, Coventry University, Feb 2011, v2

Consent Form overleaf

Informed Consent Form (for general usage)

Informed Consent Form

General

Why Computing?: An investigation of the perspectives of HE computing students

Key details about this project are described in the Participant Information Sheet (overleaf). If you have any queries about this project please do contact Lisa Payne (email: csx067@coventry.ac.uk).

- | | Please tick |
|--|--------------------------|
| 1. I confirm that I have read and understood the participant information sheet for the above study. | <input type="checkbox"/> |
| 2. I understand that my participation is entirely voluntary. | <input type="checkbox"/> |
| 3. I understand that I have the right to change my mind about participating in the study at any time and for a short period after the study has concluded (by June 2013). | <input type="checkbox"/> |
| 4. If I do want to withdraw from the study I will be able to specify whether or not information already provided can be retained for use by the project. | <input type="checkbox"/> |
| 5. I understand that participation in this study will not affect my application to any course nor my progression through my course: this research is totally separate and independent. | <input type="checkbox"/> |
| 6. I understand that all the information I provide will be treated in confidence | <input type="checkbox"/> |
| 7. Parts of the study may involve direct, personal communication either in person, by phone, or by using online facilities such as Skype. I agree to such communication being recorded. | <input type="checkbox"/> |
| 8. I understand that audio, video or image materials created as part of this study may be used on the project website, in conference presentations or journal papers. However any such items which could identify me will not be used without my explicit, separate agreement. | <input type="checkbox"/> |
| 9. I agree to take part in the research project | <input type="checkbox"/> |
- I am age 18 or over: YES ☐ NO ☐

Name of participant: Signature of participant:..... Date:

PARENTAL/GUARDIAN CONSENT *(Their agreement is also required for participants under age 18)*

I confirm that I have read and understood the participant information sheet for the above study. I agree that my child/ward may participate in this study and can participate by personal contact, by phone and online. I understand that participation will not affect any course application nor progression on course.

Name of parent/guardian: Signature of parent/guardian:

Phone number: Date:

Lisa Payne, Coventry University, Feb 2011, v2

Blank copy to be retained by participant; signed copy to be returned to and retained by researcher

Participant Information Sheet (for in-module participants)

Module

Participant Information Sheet

Why Computing?: An investigation of the perspectives of HE computing students

1. Information about the project/Purpose of the project
This study is to investigate perceptions and expectations of computing, as a course and career
2. Why have I been chosen?
This study will involve students on computing courses at Coventry University. Only students enrolled on the relevant module(s) can participate.
3. Do I have to take part?
No, participation is entirely voluntary. Your input would be very welcome though.
4. What do I have to do?
For the duration of the study you will be asked to respond to a series of questions, quizzes, questionnaires and similar activities. This will run over a period of a few months. Some contact will be online but some will be in person, maybe individually, in scheduled classes or in project-specific meetings. You would be expected to attend these and, if your absence is unavoidable, to take steps to 'catch up'. Facebook and a project website will also be used.
These research activities will build into a portfolio which will be marked as a formal module assessment (an alternative to that set for other students in the module). Your work will be assessed against criteria appropriate to the module.
5. What are the risks associated with this project?
None directly. However if you agree to join this 'module-based' research it forms an assessment and you would need to consider the implications carefully if you later wish to withdraw (see below). Absences and gaps in your research portfolio would impact on its assessed mark, of course. Repeated absences from project activities may lead us to have to withdraw you from the project, which may have negative consequences on your assessment.
6. What are the benefits of taking part?
Participation will allow you to build up a portfolio of material which will be marked and contribute formally to a module's assessment. It is hoped that participants will find elements of the investigation to be interesting and valuable.
7. Withdrawal options
Whilst you may, of course, withdraw at any time you would need to take into consideration the implications for your assessment. For your academic progress you must be sure that you've not missed any assessment deadlines.
If you did withdraw then, if you wish, all information collected about you could be destroyed.
8. Data protection & confidentiality
Data will be held in password-protected files (as far as possible). Files will usually be stored in the researcher's home. Data will be stored anonymously, against a 'participant code', from the earliest possible stage.
Any publications or other outputs will be written without identifying any participants. In addition, efforts will be made to ensure participants' contributions cannot be identified 'by deduction'.
9. What if things go wrong? Who to complain to
Director of Studies: Dr Lynn Clouder or Head of Department: Mr Chris Bland
10. What will happen with the results of the study?
This study will form the basis of a PhD dissertation. Key findings will also be submitted for publication or for presentation at conferences.
11. Who has reviewed this study?
Director of Studies: Dr Lynn Clouder and Faculty of Engineering & Computing Ethics Panel.
12. Further information/Key contact details
If you have any queries about this research, please contact Lisa Payne, Department of Computing and the Digital Environment, Coventry University. email: csx067@coventry.ac.uk

Lisa Payne, Coventry University, Feb 2011, v2

Consent Form overleaf

Informed Consent Form (for in-module participants)

Informed Consent Form

Module

Why Computing?: An investigation of the perspectives of HE computing students

Key details about this project are described in the Participant Information Sheet (overleaf). If you have any queries about this project please do contact Lisa Payne (email: csx067@coventry.ac.uk).

- | | Please tick |
|--|--------------------------|
| 1. I confirm that I have read and understood the participant information sheet for the above study. | <input type="checkbox"/> |
| 2. I understand that my participation is entirely voluntary. | <input type="checkbox"/> |
| 3. I understand that my efforts in this study will form an assessment and it will form an alternative to that set as normal for the module | <input type="checkbox"/> |
| 4. I understand that this study will involve attending some special classes and meetings. | <input type="checkbox"/> |
| 5. I understand that I have the right to change my mind about participating in the study but doing so at a late stage may mean I have missed the deadline for the alternative assessment. | <input type="checkbox"/> |
| 6. If I do want to withdraw from the study I will be able to specify whether or not information already provided can be retained for use by the project. | <input type="checkbox"/> |
| 7. I understand that all the information I provide will be treated in confidence | <input type="checkbox"/> |
| 8. Parts of the study may involve direct, personal communication either in person, by phone, or by using online facilities such as Skype. I agree to such communication being recorded. | <input type="checkbox"/> |
| 9. I understand that audio, video or image materials created as part of this study may be used on the project website, in conference presentations or journal papers. However any such items which could identify me will not be used without my explicit, separate agreement. | <input type="checkbox"/> |
| 10. I agree to take part in the research project | <input type="checkbox"/> |

Name of participant: Signature of participant:..... Date:

Blank copy to be retained by participant;
signed copy to be returned to and retained by researcher

Lisa Payne, Coventry University, Feb 2011, v1

Ethics Approval Form (for the Preliminary Study)


REGISTRY RESEARCH UNIT
ETHICS REVIEW FEEDBACK FORM
 (Review feedback should be completed within 10 working days)

Name of applicant: Lisa PAYNE Faculty/School/Department: EC

Research project title: Motivation of Computing Students - Preliminary Study

Comments by the reviewer

<p>1. Evaluation of the ethics of the proposal:</p> <p style="text-align: center; font-size: 1.2em;">Fine</p>
<p>2. Evaluation of the participant information sheet and consent form:</p> <p style="text-align: center; font-size: 1.2em;">Appropriate</p>
<p>3. Recommendation: (Please indicate as appropriate and advise on any conditions. If there any conditions, the applicant will be required to resubmit his/her application and this will be sent to the same reviewer).</p> <p> <input checked="" type="checkbox"/> Approved - no conditions attached <input type="checkbox"/> Approved with minor conditions (no need to resubmit) <input type="checkbox"/> Conditional upon the following – please use additional sheets if necessary (please re-submit application) <input type="checkbox"/> Rejected for the following reason(s) – please use other side if necessary <input type="checkbox"/> Further advice/notes - please use other side if necessary </p>

Name of reviewer:  Kay Foxman

Signature: _____

Date: 21/9/10

Participant Information Sheet (for the Preliminary Study)

Participant Information Sheet***Investigation of the perspectives of HE computing students - Preliminary Study***

1. Information about the project/Purpose of the project
This study is the first stage of a larger PhD project. This preliminary work is to conduct investigations to inform the planning and direction of the main project.
2. Why have I been chosen?
A range of computing academic staff have been selected. Some academics from other HEIs will be invited to participate too.
3. Do I have to take part?
No, participation is entirely voluntary. Your input will be very welcome though.
4. What do I have to do?
This study will comprise a semi-structured interview which will last up to an hour. If participants are willing the interviews will be recorded. Some interviews may be conducted by email.
5. What are the risks associated with this project?
None
6. What are the benefits of taking part?
Nothing, to you as a participant
7. Withdrawal options
You may, of course, withdraw at any time. In such circumstances, if you wish, the complete interview record could be destroyed.
8. Data protection & confidentiality
Data will be held in password-protected files (as far as possible). Files will usually be stored in the researcher's home.
Data will be stored anonymously, against a 'participant code', from the earliest possible stage.
Data will feed into the full doctoral study and will be destroyed with that data.
Any publications or other outputs will be written without explicitly identifying any participants. In addition, efforts will be made to ensure participants' contributions cannot be identified 'by deduction'. It is inevitable that contributions will be attributable to 'Coventry University staff' since they will form the majority of participants.
9. What if things go wrong? Who to complain to
Director of Studies: Dr Susan Morón-García, Senior Lecturer in HE Teaching and Learning, Learning & Development
10. What will happen with the results of the study?
The prime purpose of this study is to inform the design and direction of a full PhD study. The findings may be submitted for publication, which might contain participant quotes.
11. Who has reviewed this study?
Director of Studies: Dr Susan Morón-García and Faculty of Eng. & Computing Ethics Panel. Head of Department, Chris Bland, has also agreed in principle
12. Further information/Key contact details
Lisa Payne, Department of Computing and the Digital Environment, Coventry University. email: l.payne@coventry.ac.uk

To be given to each participant

Appendix E

Informed Consent Form (for Preliminary Study)

Informed Consent Form

Investigation of the perspectives of HE computing students - Preliminary Study

Key details about this project are described in the Participant Information Sheet

- | | Please tick |
|---|--------------------------|
| 1. I confirm that I have read and understood the participant information sheet for the above study and have had the opportunity to ask questions. | <input type="checkbox"/> |
| 2. I understand that my participation is entirely voluntary. | <input type="checkbox"/> |
| 3. I understand that all the information I provide will be treated in confidence | <input type="checkbox"/> |
| 4. I understand that I also have the right to change my mind about participating in the study at any time. | <input type="checkbox"/> |
| 5. I agree to be audio recorded as part of the research project | <input type="checkbox"/> |
| 6. I agree to take part in the research project | <input type="checkbox"/> |

Name of participant: Signature of participant:..... Date:

Name of Researcher:*Lisa Payne*..... Signature of researcher:..... Date:

Blank copy to be given to participant;
signed copy to be retained by researcher

Lisa Payne, Aug 2010 v2

F – Computing teachers

F.1 Supply of Specialist Teachers

The DfE conducted a census of teaching staff in 2010 which found that of the 18,400 teachers of ICT in England, only 35% (6,440) were qualified in the subject, in that they had a post A-level qualification⁴² in a computing or mathematical area (Royal Society 2012). (It is curious that the DfE saw mathematics as being relevant to the teaching of ICT, although perhaps they were assessing the capacity to cope with forthcoming curriculum changes.) This gives an average of only 1.5 'qualified' computing teachers per secondary school and, of even greater concern, 21% of schools had no 'qualified' teachers at all (Royal Society 2012). The Royal Society report recognised that this is a serious shortage of expertise in schools if more Computing is to be taught in schools.

There is a substantial need for CPD, both to train new teachers and to refocus some existing ones. Current opportunities are limited, even if the school can afford to cover the cost and release the staff to take advantage of it (Royal Society 2012). However, as the Royal Society notes, if all pupils are to experience some computing then there needs to be very many more trained school teachers. However this is not just a minor CPD requirement. For a non-specialist teacher the training need could be substantial if they are to gain enough expertise so they are confident about the computing concepts they need to deliver. As a long term remedy there needs to be many more specialist teachers, with bursaries to support computing graduates to train for the profession. (At the time of writing, June 2013, plans are coming together to deliver at least some of this.)

⁴² A degree or a teacher-training qualification specialisation

F.2 GTC Data Interpretation

A number of sources (such as BCS 2011c, Guardian 2012b) have made reference to:

"only 3 of the 28,767 people awarded QTS (Qualified Teacher Status) in 2010 had a degree in Computing."

These figures seemed implausible and worthy of investigation. Sometimes the source of this data is given as the General Teaching Council (GTC). I have spent some time chasing up this matter.

The statement was based on a mis-interpretation of a paragraph in the NESTA Next Gen report.

"Data from the General Teaching Council (GTC) suggests that of the 28,767 teachers who were awarded Qualified Teacher Status [QTS] passes and registered with the GTC in 2010, only three qualified in computing or computing science as their primary qualification (compared with 750 in ICT)" (NESTA 2011:39).

The NESTA statement was based on data provided to NESTA by the GTC in January 2011.

The statement refers to "primary qualification". This term is used by the GTC to refer to a trainee teachers' chosen main teaching subject specialism. It may or may not relate to any degree the trainee teacher may have. The GTC has confirmed the following as a more tightly defined description of the situation:

"Data from the General Teaching Council (GTC) suggests that, as at January 2011, of the 28,767 teachers who were awarded Qualified Teacher Status (QTS) passes in 2010, and registered with the GTC, only three qualified with computing or computing science as their main teaching specialism (compared with 750 in ICT)."

The contrast between the computing and the ICT figures here must reflect the lack, at that point in time, of computing as an option for teacher training and the (perceived or real) lack of employment opportunities for computing teachers. In

2010 there was little of either. It is almost more surprising that even three new teachers declared computing as their primary qualification when registering.

As an interesting adjunct, other data I have from the GTC (also as at January 2011, created for Simon Humphreys of CAS) show that there are in total 10,825 teachers (some registered with the GTC, some not) whose main teaching specialism is some aspect of ICT or computing. There are 6,343 teachers (some registered with them, some not) who have an undergraduate or post graduate degree in some aspect of ICT or computing, most of these have degrees in a technical area of computing. 3,193 teachers are in both categories, having ICT or computing as both their teaching specialism and the subject of a degree. Considering there are about 600,000 registered teachers, these are all tiny proportions.

But this also shows that of people with an ICT or computing degree who go into teaching, only 50% use this subject as their main teacher training specialism. Some of the others will go into Primary teaching and that (Primary teaching) will then be recorded as their specialism. Of course, these teachers may or may not be using their technical knowledge in their job.

The Royal Society report (2012: 71) looked at Department for Education (DfE) data from the Schools Workforce Census (November 2010). This showed there were 18,400 ICT teachers in secondary schools in England. Of these, 35% (6,440) have a relevant degree. Twenty five per cent (4,600) possessed both a relevant first degree and teacher training qualifications. (A further 9% have a degree in some other discipline.) Thus, 65% were not considered as 'qualified' by the DfE. Surprisingly, this does not refer to QTS status. Rather these 65% of ICT teachers possessed neither a relevant degree nor a teacher training qualification.

These figures do not immediately seem to accord with the GTC data described above. There are a number of reasons for the apparent discrepancies. Firstly

Appendix F

the GTC data includes Primary as well as Secondary school teachers. There will be very few computing or ICT specialists in Primary education so this will be a very tiny source of difference. Secondly the GTC data includes teachers who register with them and some, but not all, of those who do not. Teachers in private schools in particular do not need to register. Thirdly the GTC data uses the specialist subject declared at the time of registration. Even allowing for the first two points, the fact that the DfE survey identified very many more ICT teachers (18,400) than the GTC data shows (10,824), suggests that many teachers move into ICT teaching after they have registered with a different specialism. It may well be that some of those teachers have a specialist degree but this is not likely to account for very many.

The GTC was disbanded in April 2012. However I have both sets of GTC data and their permission to pass it on, if it is of interest to anyone.